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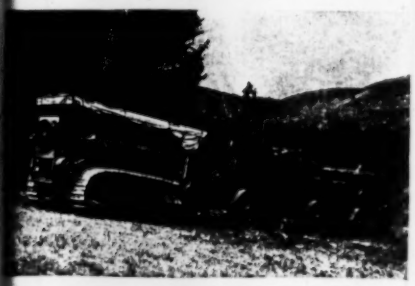
April 7, 1921

Engineering News-Record

Devoted to Civil Engineering and Contracting

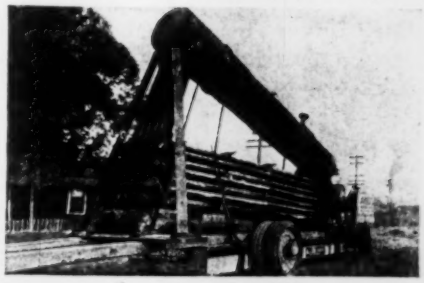
McGraw-Hill Company, Inc.

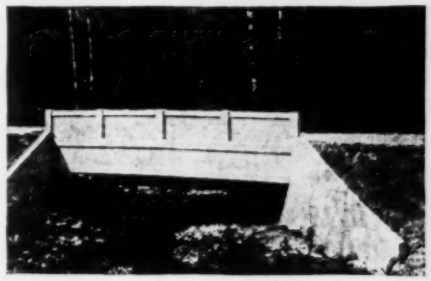


For Better Highway Bridges

Engineering News-Record for months has been emphasizing the deficiencies in highway bridges. This was in pursuance of a definite campaign, an effort to crystallize sentiment and to focus attention on the bridge among the highway problems that demand solution. Many bridge engineers and some highway engineers appreciated the situation but something forcible and continuous was needed to wake up the majority of the profession. As a result of the campaign, interest in highway bridges has been aroused, but constant hammering is required. This *Engineering News-Record* purposes to continue. Through its pages it will keep its readers informed of the progress that is being made.

In this issue are three thoughtful contributions to the subject—an article on making highway bridges safe by Lewis E. Moore, of the Massachusetts Public Utilities Commission and two articles on impact and its effect by Col. W. D. Uhler and Willis Whited, of the Pennsylvania Highway Department.





Among the Articles in This Issue Are:

Six Stories Added to Reinforced-Concrete Building

Connections of old four-story concrete office building to ten-story extension required structural steelwork.

By Walter H. Wheeler

Hydraulic Fill Practice on Terrace Reservoir Dam

Studies of flume lining place cast-iron plates first and green spruce blocks second in durability.

By John E. Field

The Prediction of Probable Rainfall Intensities

A study based on records at Central Park, New York City, for the fifty-one years, 1869 to 1920.

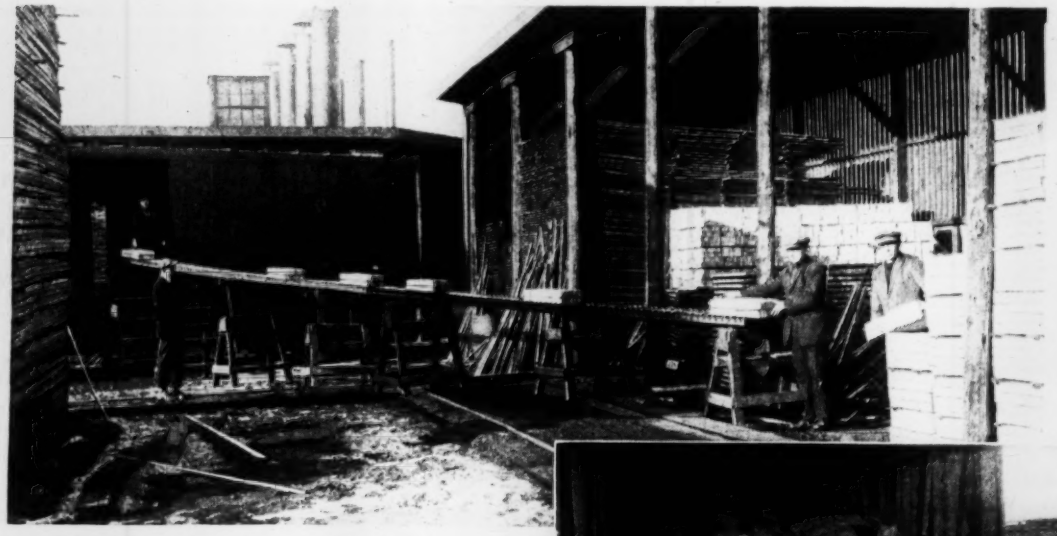
By Kenneth Allen

Concrete Road Mix Proportioned at Central Plant

Clamshell bucket and belt conveyor load bins and three-compartment motor trucks deliver to mixer.

By H. T. Tuthill

Monthly Price List of Construction Materials



Above—Unloading square stock at the A. Murphy Chair Co., Detroit, Mich.
Below—Unloading flour on pallets (wooden platforms), at the Hathaway Baking Co., Boston, Mass.

Engineering and Ethics

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. MEHREN *Editor*

Volume 86 — NEW YORK, THURSDAY, APRIL 7, 1921 — Number 14

Is Engineering a Business or a Profession?

IS ENGINEERING a business or a profession? That, as we see it, is the essence of the controversy in New York State regarding engineering practice by corporations and unrestricted partnerships (those having non-engineers as members).

If a corporation composed in part of non-engineers is permitted to use the designation "engineers," then non-engineers are legally given the status of engineers, which not only is a negation of the fundamental purpose of the licensing law but thwarts the efforts of more than two generations to put engineers on a professional plane. The law would not only refuse to restrict engineering practice to those qualified for it, but would explicitly sanction practice by non-engineers so long as they hired engineers to work for them.

Equally contradictory and destructive is legal sanction of practice by "B and C, engineers," a partnership in which B is an engineer and C is not. C would be given an engineer's status by the very law which forbids him to practice as an individual.

The legal profession has appreciated these contradictions and the law, therefore, permits only those legal partnerships in which *all* the members of the partnership are members of the bar, and forbids entirely practice by corporations.

In the New York controversy the opponents of corporative practice did not declare their approval of partnerships composed wholly of engineers and thus allowed an erroneous impression of their position to get abroad. Should corporations and unrestricted partnerships be prohibited from practicing, the law would require amendment explicitly permitting practice by wholly engineering partnerships.

The issue is plainly a fundamental one. As Colonel Wilgus said in his letter in the issue of March 24, we are "at the parting of the ways." To which side shall we go? The way to the left leads backward, against the direction in which engineers, with unselfish devotion, have been aspiring for generations.

Guessing at the Traffic Problem

TRAFFIC congestion held a prominent place at a recent meeting of the New York Section of the American Society of Civil Engineers. The character of the discussion furnished further corroboration of the views frequently urged by *Engineering News-Record*, that traffic control, regulation and facilitation are among the chief municipal engineering problems of the day.

The opening paper, read by Charles W. Leavitt, made the radical proposal that the dense north-and-south traffic of New York City be handled in part on elevated expressways cutting through the built-up blocks between the principal avenues, with vehicular tunnels under Central Park on certain of the lines. The proposal can hardly have been made seriously. We take it that Mr. Leavitt suggested a "shocker" to awaken New York to the growing seriousness of the problem. Amos Schaeffer, consulting engineer to the Borough President of Manhattan, estimated the cost of the Leavitt scheme at between $1,365,000,000 and $1,800,000,000, the higher figure being more than the city's bonded indebtedness of $1,589,000,000. Of course, the whole plan could not be taken in hand at once, but even so its proposal is so far ahead of the times as to warrant little consideration.

What is notable, though, and deserving of emphasis, is that Mr. Leavitt's paper and Mr. Schaeffer's rejoinder indicated that no adequate studies had been made either of the traffic or of means of providing for and controlling it. Under such circumstances it is not possible to propound a solution that will carry confidence. It will be a costly procedure to get the facts, but they must be obtained and the sooner the better. Some traffic studies have been made by the city on main avenues, by the vehicular tunnel commissions in lower Manhattan, by railroad agencies in connection with "store-door delivery." But these are fragmentary. A thorough study is needed.

What is the character and volume of traffic on each avenue? What changes on certain less-traveled avenues would tempt traffic from the heavily congested routes? Is there a large number of "light" trips that would be eliminated by "store-door" delivery, such as is being urged on the railways? What is the relation of traffic delay on the avenues to volume and character of cross-town traffic? These are but a few of the questions that need answer. When full data are in hand we may proceed to arrive at an intelligent solution of the traffic problem but not before. Engineers have a responsibility in advancing the day when the data will be secured.

Federal Inquiry on Roads

DUE to recent disclosures regarding highway conditions in Arkansas, made by the Federal Bureau of Public Roads and in articles in the New York *Times*, there is talk in Washington of a senatorial investigation of federal-aid roadbuilding. Senator King of Utah has announced that he will introduce an appropriate resolution.

While there will be objections to such an investigation we believe that in the sum total it would do much good. It would undoubtedly result in giving the Bureau of Public Roads greater authority in designating where the federal funds are to be spent. Despite the efforts of the bureau to put the money on important links of through routes, certain states have succeeded in having the funds spent on odd stretches of road. This has been due, in part, to the vicious system by which

some states have forced the counties to match the federal funds. That practice should be forbidden by law, and such prohibition would probably be one of the results of an investigation. Other benefits that could be counted on would be still greater federal authority to force the organization of adequate state highway departments and the beginning of that which the bureau has consistently advocated—the classification of roads in order that there may be a sure basis for the economical expenditure of federal and state funds.

Moreover, from the mere standpoint of satisfying the public that the government investment of over $200,000,000 in roads is wise, the inquiry might be worth while. It is, of course, too early to pass judgment on the disposition of the whole of that amount, but an idea of the soundness of policies can be gained.

The inquiry would necessarily involve, also, consideration of financing by states and counties to meet the federal funds. There is not a man with good financial sense who has not entertained doubt as to the wisdom of the epidemic of $50,000,000 bond issues. The construction efficiency of the expenditures is not the prime matter at stake, but whether, in view of the rapidly mounting tax rates of recent years, every part of the country is warranted in making heavy expenditures, even though there will be large transportation benefits. A $100,000,000 bond issue in one state may be thoroughly sound, while an issue of $25,000,000 in another may not be defensible.

We entertain no illusions as to the efficacy of senatorial investigations. They can be excellent mediums for the spreading of misinformation, but by and large the highway improvement program is so sound that it can afford to take the chances involved in exchange for the benefits that are quite certain to accrue.

Legislation Will Not Build Homes

BOTH the multiplicity and the indirection of the legislative remedies for the housing shortage proposed by the Calder Committee, as announced in these columns last week, point to the futility of trying to solve this problem by legislative means. Here was an able committee, with all the expert aid the government commands, which after months of study, travel and hearings, could only suggest a number of roundabout tax schemes to produce the millions of houses that would have been built had not the war wrecked the world. The plain fact that a number of people are trying to dodge is that home building will not speed up until prices and wages come down. There is no use blinking this fact nor to try to argue oneself out of the situation by resort to economic theory or psychologic imaginings.

The case of the residence is fairly simple. According to the sociologist and statistician a week's wages makes a fair month's housing charge for the individual, whatever his income. Before the war then, when money was around 5 per cent, taxes 1 per cent, and maintenance and repairs 2 per cent, and assuming heat, light and other current expenses to be 10 per cent of the building charges, a man could afford to own a house valued at 130 times his weekly salary—a $1,200 man could own a $3,000 house, a $5,000 man could own a $13,000 house. Today these same houses cost twice as much to build and the charges add up roughly to 12 per cent, say 6 per cent for interest, 2½ per cent for taxes, and 3½ per cent for maintenance, so that, sticking to the same standard of living—a week's salary for a month's rent—the rental has tripled and the man who would build or rent the $3,000 house of 1914 must have an income of $3,600 a year and he who builds or rents the $13,000 house of that time must now draw annually $15,000. Wages and salaries have gone up since 1914, to be sure, but in no such proportion as this for the average man. What has happened is that the average standard of housing has gone down and *must stay down* until costs fall.

The tax and loan reforms suggested by the Calder Committee and those put into force in some places, notably New York City, have some effect on group housing (such as apartment buildings), which is a matter of large financing, but they cannot solve the entire problem because all they do is to reduce by a small percentage the charges against the actual cost of housing. In other words they tend to lower the 12 per cent, which has been boosted from the 8 per cent of seven years ago, but they lower that only a small amount and they lower not at all the actual cost of building, which is the main item in the increased burden of housing. Until this actual cost begins to drop, so that the relation between income and house expense more nearly approaches the earlier figure, people will continue to live in their cramped quarters to which high rent charges have brought them. All the estimates of a shortage of a million houses, which is so often held to indicate, of itself, the necessary imminence of a building boom, will continue to mean nothing. The people of Austria and China are short of food, but that deplorable fact does not automatically feed them.

Proposed Constitution of Civil Engineers

FOR some weeks the proposed revised constitution of the American Society of Civil Engineers has been in the hands of the members for study. The important revisions are confined to a relatively few items. This is a wise course, and in the interest of an early termination of discussion on internal affairs.

It became apparent last year that there were two points upon which the majority of members were agreed: (1) That the local sections should be strengthened, and (2) that directors be elected by districts. With the latter was coupled in many quarters a demand that (3) there be a proportionate representation in the directorate. These three points have been, wholly or in part, met in the proposed revision.

The locals have been given a constitutional status, and the board is authorized to contribute up to $3 per member to their support. The provisions do not seem wholly to meet the situation. The local sections in the past have been step-children. Their position is changed somewhat by the proposed revision, but to assure constant and adequate thought on their development, there must be explicit machinery for considering their problems. The least that could be done would be to establish a standing committee on local sections. An amendment to that effect is called for. The authorization of such a committee should not be left to the discretion of the board, but be made mandatory.

Representation on the board would, under the revision, be in proportion to district membership, a proposal to be heartily commended. New York's nine members would be reduced to four. The constant shifting of district boundaries, however, is not desirable.

The method of nomination proposed is a primary system with two letter ballots. This is in accord with

the principle, which has widespread support, that there should be a more democratic method of selecting officers. The primary system, while it would seem to have the disadvantage of not affording discussion of the qualifications of candidates, does not, in reality, bar such discussion. It would throw it into the sections. Without a doubt some systematic method of section functioning in nominations would develop as an extra-constitutional procedure.

The proposed election procedure departs sharply from the clearly expressed demand that directors be elected by their respective districts. That demand, however, cannot, under the society's charter, be satisfied and must be dismissed as impossible, unless the trustees and directors be made separate bodies, obviously a cumbersome arrangement. But the law does not forbid the *nomination* of directors by the respective districts. The proposed constitution says that corporate members in zones and districts are "expected" to submit names for the respective vice-presidential and directorship nominees. This is not sufficient. The constitution should state explicitly that only members of a district may participate in the nomination of a director for that district and only members of a given zone for the vice-presidential representative of that zone.

An obvious objection to the method of nomination is that it spreads the election of officers of the society over 9½ months. One election would be concluded in January, and the machinery for the next election would start 2½ months later. However, if a primary system by letter ballot be accepted, it does not seem feasible to shorten this to a material extent. The months of July and August are not conducive to effective society activity. This long drawn out procedure may eventually cause the elimination of one of the primary ballots and the substitution therefor of suggestions by the sections. This would also tend to strengthen the position of the sections.

Within the limits set by adherence to the present fundamental conception of the society, the revisions strike us, on the whole, as being satisfactory. In the essential points they touch only on matters on which thought has been crystallized. In thus limiting the revision, the committee has sensed the need for getting the constitution out of the way quickly and allowing the society to settle down to technical work.

Work Ahead

BEFORE the country's highway system will be adjusted to the loads and speeds of modern power-vehicle traffic, hundreds of thousands of road bridges will have to be made strong enough to carry this traffic. It is going to be an undertaking of tremendous size, mainly in point of money an time required, though it has also many engineering difficulties. Something has been done during the last ten or a dozen years, but it is little in comparison with the total to be accomplished. The bulk of the work is ahead of us.

Some states have been far-seeing and fairly active in bridge modernization, but the larger number have spent almost all of their available road moneys on hard surfacing. At best only the structures on main roads have been dealt with, the byroad being left practically out of the reckoning. Unfortunately the motor truck does not stick to the main roads but goes where its business calls it. The problem grows out of this fact and out of the impossibility of carrying twelve to twenty-ton traffic on five or ten-ton bridges. With insignificant exceptions the bridges are a generation behind the road itself.

Amid the general clamor for extension of hard surfacing, it has not seemed possible to get a hearing for demands that great sums ought to be spent on the bridges. Citizens and legislators can hardly be expected to understand such demands until a succession of disastrous wrecks convinces them—or until engineers, who know the situation, make organized effort to bring the facts home. When the wrecks come it will be too late. Bridge improvement is a matter of years. Hence the necessity for awakening the public without further delay; and hence also an opportunity and a responsibility for our profession.

Evidence that engineers are thinking about the highway bridge problems is found in several articles in this issue, dealing with loads, impact and reinforcement. Such thinking means progress in preparing for the big program ahead. It means also that the subordination of the highway bridge to the railway bridge is nearing its end, and the individuality of the former recognized.

Considered as a transportation machine the highway system differs from the railway in this important respect, among others: roadbed and rolling stock of the highway are under separate control, while those of the railway are under unified control. In the case of the highway thousands of independent highway users play a part in fixing the future of the traffic, not merely as to amount and distribution but also as to loads, types of vehicle and motive power. In consequence, there has been constant flux in the technical fundamentals of pavement construction. For the same reason the bridge problem, which involves safety to life and limb, is a matter of wise judgment, and a fair amount of prophetic gift must be brought into play in dealing with it. Paraphrasing what Mr. Moore says (on page 580), those who build or rebuild with too little vision will see their successors do their work over.

Months ago *Engineering News-Record* pointed out the critical nature of the existing situation, and urged the need of concerted, purposeful action. We proposed that action be taken to set a limit on loads and speeds of power vehicles, in order to maintain conditions within reasonable bounds of safety, pending more thoroughgoing steps to co-ordinate bridges and traffic. The argument is similar to that so frequently urged here and elsewhere for traffic regulation. It is essential that, by systematic effort, the public be awakened to an understanding of highway bridge facts, and thereby stirred to action.

Through their widespread organization in technical and professional societies, engineers have a potential influence larger than they have perhaps realized as yet, large enough, in any event, to enable them to make a first step in the direction indicated. They can, we feel sure, by clear and convincing presentment of facts to the authorities secure the official designation of an engineering commission which, in co-operation with the state highway authorities, would survey the actual condition of bridges and traffic and determine in plain view of the public what dangers and what needs exist. Public service of this kind would supply a broad foundation for further efforts in many directions, extending if need be even to appeal to the authorities for closing of bridges or restriction of traffic, until bridge modernization becomes part of the public program.

Making Highway Bridges Safe for Modern Traffic

A Discussion of Loads, Impact Allowance, Floor Strength and Other Factors of Safe Design and Maintenance, with Emphasis on Need for Developing By-Roads and Providing for Future

By Lewis E. Moore
Bridge and Signal Engineer, Massachusetts Department of Public Utilities, Boston, Mass.

UNDER the changing traffic conditions created by the increase of motor vehicles, the problem of making our highway bridges adequately safe is an exceedingly live one. Despite its financial and engineering difficulties it demands prompt attention; we cannot continue to neglect it in the comfortable hope of getting by somehow and shifting the responsibility to succeeding generations.

There has been considerable divergence of publicly expressed opinion on many of the engineering questions involved, and therefore I offer the following comments from the standpoint of eighteen years' experience in both civil and military practice, the former largely in Massachusetts, covering railroad, street railway and highway bridges, the latter principally in France; with the intention of indicating the features which appear to possess paramount importance.

Loadings for Design

Loading is a primary problem. In 1915, when rewriting the "Specifications for Highway Bridges Carrying Electric Railways" issued by the Massachusetts Public Service Commission, I abandoned the 15-ton traction engine formerly used in favor of a 20-ton (gross weight) truck with 14 tons on one axle, wheels 6 ft. apart, axles 12 ft. apart. These specifications were so drawn that they could be used for purely highway bridges, and all experience since then has shown their value for present-day bridge service. The truck specified was required for all localities, even outlying territory on secondary roads, because it was felt that railroads and street railways would not build new branch lines to any extent in the future (at least in New England) and that the motor truck would be used for heavy transportation into remote districts. Trucks weighing 18 tons have been operated on the highways of Massachusetts within my own experience.

The need of good bridges on by-roads should be emphasized, as it is entirely possible that good bridges, by making it possible to drag heavy loads into remote places, may actually aid in the useful development of unused localities. Further, when repairs to main roads are under way, the by-road, used as a detour, must carry the heavy main-road traffic. Travel on one of the two main east-and-west roads in Massachusetts was greatly discommoded not long since because, while a bridge on the main road over a railroad was being replaced, an inadequate bridge on the most available detour failed under a truck.

Motor traffic loads give heavy concentrations on individual trucks, but owing to the dimensions of the trucks and to traffic conditions these concentrations are not as a rule unduly close together. The 20-ton truck above mentioned, if assumed to occupy a width of 10 ft. and a length extending 10 ft. both in front of the front axle and behind the rear axle, or, in other words, an area of 10 x 32 ft., will cover 320 sq.ft. of roadway. The average load over this area is only 125 lb. per sq.ft. Herein lies the explanation of the relative frequency of floor failures and infrequency of truss failures in old bridges. The design loading, then, should comprise a heavy concentration or concentrations for the flooring, stringers and floorbeams, and a uniform load, say of 100 or 125 lb. per sq.ft., for the trusses, *using also*, however, a single excess load for the trusses, which may be placed anywhere and which is equal to the difference between the end shear on the floorbeam produced by the concentrated live loading and that produced by the uniform live loading. The use of this excess load will insure that all the details of the truss, such as hangers, will support the maximum load which the floor can carry; and at the same time will avoid the needlessly heavy truss which would result from using maximum floorbeam reactions at all panel points at once.

The importance of military loads should not be underestimated; we must not dismiss possible military necessity completely from our calculations as we did before the existing war. Axle loads up to 40 tons are now contemplated. Such a load can safely be carried on a bridge designed for a 20-ton auto truck with 14 tons on one axle, if the design is made with 50 per cent impact allowance.

Will Loads Increase?

It seems possible that the trailer will come into greater use in the future; such extension is the natural consequence of a desire for more economical transportation. Tractive force is a necessity if trailers are to be hauled and it can only be gained by weight on the driving wheels of the tractor. This fact will exert its influence toward increasing wheel loads. Whether the caterpillar tractor, which distributes its load over a considerable area, will prove to have a very wide field of usefulness on surfaced roads is an open question, and discussion of it is beyond the scope of the present article.

To say that the limit of weight has been reached would be as rash a prophecy as the one made in some quarters ten years or more ago that the locomotives and cars on the railroads had reached their maximum size and weight. Heavier unit loads have proved more economical on the railroads, and it is very likely that the same will hold true on the highways. Highway surfaces will continue to improve and loads will continue to increase. Restrictive legislation will be repealed as transportation demands increase, and the man who designs bridges today for light loads will see someone else rebuild them tomorrow because of their inadequacy. Inadequate bridges were not permitted to hinder the development of the full capacity of the railroads, and neither will they be allowed to block similar development of the highways.

Fortunately there have been no bridge failures due

to structural weakness in bridges under the jurisdiction of this department since its organization in 1887. The fact that other classes of highway accidents are more numerous than bridge accidents does not condone or excuse the latter, and inspection to maintain safe conditions is of prime importance.

Wooden bridges can be inspected as effectively as those of other types by taking sufficient pains. I take decided issue with the statement made by one writer that it is beyond the power of any man to say whether or not an old timber truss bridge is safe. Any experienced bridge man of good judgment, with a hammer, a ½-in. auger, reasonable patience and some elbow-grease can determine that matter without any doubt whatever.

Generally, the weak part of the floor under modern truck loads is as a rule the floorbeam. Wooden plank floors of the ordinary construction are proving to be inadequate to sustain the heavy concentrated loads now met with. Cases of the breaking of such flooring are increasing in frequency. Owing to the increasing cost of lumber, its decreasing longevity, its perishable character and its continual decrease of strength during its life, it is very doubtful if plank floors are now economical, at any rate east of the Rocky Mountains. The wooden stringer, for similar reasons, is giving way to the steel I-beam.

Failures of steel I-beams are generally due to crippling of the web, and I have seen beams bent to an S-shaped cross-section by overloading. A point to be kept in mind in designing I-beam stringers is that they need stiffeners at points of concentrated loading and at reactions just as much as plate girders do. Many designers seem to assume that because the flange and web are rolled out of the same material with no riveting, stiffeners at once become unnecessary. Frequent cases of crippled I-beams indicate the fallaciousness of this convenient lack of reasoning.

Preferable Types

For truss bridges a 6-in. concrete slab floor, heavy steel stringers and floorbeams and a moderate truss give an entirely adequate and reasonably economical structure.

The masonry (I include reinforced concrete) arch is a structure whose real possibilities are not generally realized. The distributed live-load capacity of an arch ring with sound abutments is practically unlimited. It seems therefore undesirable, whenever it can be avoided, to place a superstructure of beams whose capacity is decidedly limited on top of an arch ring of practically unlimited strength. European engineers would probably use an arch superstructure in such a case, and we may profitably learn from them.

When *financially* practicable, I always recommend an earth-filled concrete arch, because of its unlimited live-load capacity and because it needs no maintenance other than that given to the highway surface. Most highway bridges get no maintenance anyway, so it is just as well to build a type that can safely be neglected.

The idea that smooth rubber tires tend very much to decrease impact is, I believe, erroneous. The development of the theory of impact today is away from the single-blow idea and toward that of vibration. The great vibration of bridges under rubber-tired traffic is a matter to which I have given close attention for the past five or six years. The result of my observation has been that an ordinary pleasure automobile weighing perhaps two tons will produce far more severe vibration in a bridge than will a 30-ton trolley car. I have spent days in the field verifying this observation and am sure of the correctness of the conclusion.

While no actual measurements of the amount of the impact were made, the study led to the use of a 50 per cent impact allowance for trucks in the above-mentioned specifications and a continuance of the 25 per cent impact allowance formerly used for trolley cars.

While abroad I found that some British engineers had reached the same impact allowance (50 per cent) at practically the same time and by substantially the same course of reasoning.

Repair and Reinforcement

The matter of repairing and strengthening corroded and weak structures is bound to be of increasing importance in the future. Many methods need to be employed, and the subject is worth detail treatment in a separate discussion.

To illustrate the fact that simple expedients often suffice, it may be mentioned that in three cases, one of them a wooden truss, wooden stringers which rested on top of the floorbeams were replaced at my suggestion by Bethlehem H-sections extending continuously through the whole span and of sufficient strength to sustain their proportion of the live load for the full span even if all the rest of the bridge should fall away from them. In one of these cases two successive 55-ft. spans of very light steel construction were reinforced in this way, with the result that the life of the old bridge has been indefinitely prolonged.

Sometimes a center truss under the floorbeams will cheaply reinforce weak beams. It is easy to say "new bridge" in such a case but proper study and the exercise of a little ingenuity may economically prolong the life of an old structure very considerably at far less than the cost of a new bridge.

Federal-Aid Highway Work in Missouri

Thirty-nine contracts aggregating in value approximately $6,500,000 and entailing the construction of 351 mi. of highway have been entered into by the Missouri State Highway Department for the construction of Federal-aid projects. The largest number of projects involving the greatest expense in construction are located in Division 1. In this division, eleven projects total $2,687,616 for 81.1 mi. The above table is a tabulation by divisions of details referring to the construction of the thirty-nine projects.

TABLE I.—MISSOURI FEDERAL-AID PROJECTS ON WHICH CONTRACTS HAVE BEEN AWARDED—TO SEPTEMBER 15, 1920

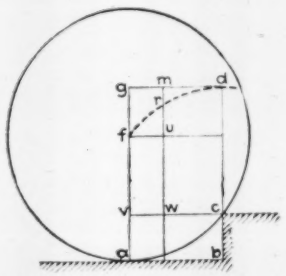
Div.	No. Proj.	Length Miles	Contract Price	Federal-Aid	State-Aid
1	11	81 10	$2,687,616 18	$1,022,033 89	$261,995 36
2	1	10 26	122,889 14	61,444 57	6,360 00
3	8	71 80	560,038 11	237,174 45	68,972 36
4	5	33 77	803,348 43	335,020 02	33,464 90
5	9	80 43	1,174,512 90	550,026 09	72,142 10
6	5	74 04	1,132,645 62	514,264 18	99,196 88
Totals.	39	351 40	$6,481,050 38	$2,719,969 20	$542,131 60

Analysis of Roughness Impact on Highway Bridges

Floor Irregularities the Principal Source of Impact—Formula Derived From Study of Motion of Wheel When Striking an Obstacle Indicates an Increase of Two-thirds the Load for Three-Inch Roughness

By Willis Whited
Consulting Bridge Engineer, Pennsylvania Highway Department, Harrisburg

TWENTY-FIVE years ago an elaborate investigation of the centrifugal force developed by the passage of a load over a beam, the beam deflecting under the load so that the path of the latter is a curve, was carried out by H. Zimmermann. It may be found in "Handbuch der Ingenieurwissenschaften," 4th ed., Part 2, vol. 3, p. 39. The centrifugal force in question is evidently proportional to the square of the speed of the load. But Zimmermann found it to be quite small even for railroad trains. In the study of highway bridge impact it may therefore be ignored as being a factor of no practical consequence.



WHEEL STRIKING OBSTACLE

In the "Handbuch" there appears also (p. 44) a discussion by Professor Melan of an approximate method for determining the stresses due to the rapid application of a load to the various members of a truss bridge. Calculations based on his formula show that for the maximum speeds of heavy trucks the impact due to this cause may be neglected.

The impact on bridges due to the roughness of the road, however, has not been discussed from a scientific standpoint by any writer, so far as I know. Many tests and much study have been devoted to the impact on roadway slabs, but the results would require much modification to be applicable to bridges. An attempt will now be made to discuss this subject on the basis of the ordinary principles of dynamics. Two phases will be taken up: first, the impact produced when a truck wheel strikes an obstacle, and second, the impact when it jumps off the obstacle.

We will assume that the deflection of the springs, tires, and framework of a truck, as well as that of the bridge structure, is proportional to the load, and that the total amount of this deflection is D_1 under the full assumed static load. In the sketch herewith ab is level roadway and bc is the face of an obstacle. The wheel moves through distance ab in time t_1 seconds, which is the time from the instant the tire touches the obstacle to the instant the vertical through the axle reaches the obstacle. We will denote the distance ab by K, the total load on the wheel by W, the height of the obstacle bc by h, the radius of the wheel by R, and the variable height of the load measured vertically above ab by s.

When a truck wheel strikes the obstacle the tire is first compressed at c about as much as at a, and then the center of the axle describes an arc fd about c in the time t. A force in addition to the static reaction is required to lift the axle in this process. It is a force of acceleration, which we will call U. It is shown in works on mechanics that velocity equals $\frac{ds}{dt}$ and acceleration equal $\frac{d^2s}{dt^2}$, or in this case gU/W, where g is the force of gravity, 32.2 ft. or 386 in. per second per second. The force U compresses the springs and framework of the truck so that the sprung load of the truck does not describe an arc parallel to fd but describes a curve, each point of which is below the corresponding point of fd a distance equal to UD_1/W. As will be seen, $fg = bc$ and $gd = ab$. The horizontal velocity of the axle is uniform and equal to t_1/ab. The time required to pass from f to any point r of the path will be denoted by t, the variable time.

From the figure,

$$fv = \sqrt{R^2 - K^2};\ wr = \sqrt{R^2 - (md)^2} = \sqrt{R^2 - \left(\frac{t_1 - t}{t_1} K\right)^2}$$

The height ur through which the axle rises in time t is $wr - fv$, or

$$ur = \sqrt{R^2 - \left(\frac{t_1 - t}{t_1} K\right)^2} - \sqrt{R^2 - K^2}$$

The height through which the sprung load rises is s, and the total compression of the springs, etc., at the end of time t is

$$ur - s = \frac{UD_1}{W} = \sqrt{R^2 - \left(\frac{t_1 - t}{t_1} K\right)^2} - \sqrt{R^2 - K^2} - s$$

whence we have the differential equation

$$\frac{d^2s}{dt^2} = \frac{gU}{W} = \frac{g}{D_1}(ur - s)$$

$$= \frac{386}{D_1}\left[\sqrt{R^2 - \left(\frac{t_1 - t}{t_1} K\right)^2} - \sqrt{R^2 - K^2} - s\right]$$

If we place $386/D_1 = a^2$, and $ur = T$, we shall have

$$\frac{d^2s}{dt^2} + a^2 s = T$$

which may be solved by the method given in Johnson's "Differential Calculus," Art. 82, with the following result:

$$as = \sin at \int T \cos at\, dt - \cos at \int T \sin at\, dt + C_1 \sin at + C_2 \cos at$$

$$\frac{ds}{dt} = \cos at \int T \cos at\, dt + \sin at \int T \sin at\, dt + C_1 \cos at - C_2 \sin at.$$

A complete solution of this equation is very difficult but an approximate solution can be obtained for any given numerical values of the constants by placing t equal to zero, $\frac{1}{2}t_1$, t_1, successively for the quantities under the integral sign, adding by Simpson's rule and multiplying by sin at and cos at, respectively; the constants C will be found to vanish. The same procedure may be followed in obtaining the value of $\frac{ds}{dt}$, the upward velocity of the load when the axle reaches d.

The value of D_1 for ordinary heavy trucks will not vary greatly from 4 in. At speeds of 15 miles per hour and upward, and obstacles in the neighborhood of 3 in. high, the value of s when the axle reaches d will be found to be less than $\frac{1}{4}$ in., and $\frac{ds}{dt}$ at the same instant

will be small, so that the spring will be compressed an amount nearly equal to the height of the obstacle.

A little consideration will show that the impact is somewhat less than the force required to compress the springs, etc., an amount equal to the height of the obstacle. The tire is much more rigid than the springs, and if, as usual, we consider everything below the springs as unsprung load we will find that the force required to lift the unsprung load is greatest when the tire first strikes the obstacle, steadily diminishing till the axle reaches *d*, when it becomes zero. It is therefore not necessary to add the two impacts together, as they do not occur at the same time.

If the motion of the load is analyzed after the axle reaches *d* its equation of motion will be found to be the same as that of a vibrating spring, which would indicate that the load will rise above its first position a distance somewhat less than twice the height of the obstacle. If the obstacle is of sufficient length to catch the load as it falls the maximum impact will be caused by the load striking the obstacle, but if the obstacle is short so that it lands on the same level as *ab* the maximum impact will occur at that time. Personally, I hardly think it wise to provide for an impact as great as that would give.

If we base our impact allowance on the impact developed when a wheel mounts an obstacle 3 in. high the proper allowance will be about ⅔ the sprung load, assuming the speed to be about 15 miles per hour. If a 4-in. obstacle is assumed the proper allowance may reach about 0.8 of the sprung load.

When a truck wheel passes off from an obstacle the motions are somewhat complicated. The center of gravity of the vehicle will describe a parabola, but, as the springs are rapidly released, a vibratory motion will be produced, in which the sprung load will vibrate in a direction opposite to that of the unsprung load, the amplitude of the two vibrations being inversely proportional to the two loads. If the speed exceeds about 15 miles per hour the vibration of the wheels will be checked but little, if any, by striking the obstacle. The effect will be that the impact of the unsprung load striking the floor will be greater than that of the sprung load. The amount of this impact will depend upon the compressibility of the tire, which is much greater in the case of a pneumatic than of a solid tire. Pneumatic tires are not used on the heaviest trucks and solid tires vary quite widely in compressibility, but in the majority of cases the impact will be less than that due to the truck striking an obstacle of equal height, as discussed above.

I therefore feel that the most logical basis for computing impact in any member of a highway bridge would be to add to the maximum stress due to the assumed maximum static load a stress equal to that due to a single load about two-thirds the sprung load on any wheel, applied at whatever point on the bridge floor will give the maximum stress in the given member.

City Faces Damage Suits After Typhoid Epidemic

As a result of a typhoid outbreak in Pittsburg, Cal., ascribed to a poluted water supply, reference to which apepars in *Engineering News-Record*, Dec. 30, 1920, p. 1288, in the Letters to the Editor column, this issue, 21 suits have been filed against the city by persons who were sick during the outbreak. Damage claims are reported to total about $140,000.

Impact Under High-Speed Traffic on Highway Bridges

Addition of Twenty Per Cent of Four-Wheel Load Found Sufficient to Allow for Maximum Roughness of Foor

By W. D. Uhler

Chief Engineer, Pennsylvania State Highway Department, Harrisburg

IMPACT on highway bridges may be analyzed by applying well established principles of mechanics to the actions involved and the particular values of the disturbing elements assumed. The quantities on which impact will depend are: the speed of the vehicle, the roughness of the roadway, and the amount of deflection of springs, tires, etc., of the maximum-weight truck under its maximum load.

We can but forecast or assume the possible changes in the elasticity, the speed and the maximum loading of trucks that will be used a generation or two from now, at which time many of the bridges we are now building will still be in good and serviceable condition. Assumptions as to the factors of impact can be made only with considerable hazard at this time, inasmuch as the truck business is still in its infancy, and inasmuch as it is fair to presume that it will grow as rapidly as the improvements in our road system will permit. The assumptions are further hazardous because we do not as yet know whether the future economy of truck transportation will be in the direction of higher speeds, heavier loading or the increased use of trailers.

It would seem that highway bridge impact is due to the following causes:

1. Increase or decrease of the load due to centrifugal force when the bridge floor has a sag or camber.
2. The hammer action caused by a rigid body striking the bridge.
3. Roughness of the road surface.
4. The dynamical effect of a load passing over the bridge independent of the curvature or roughness of the roadway.

These points will be discussed in order.

Camber and Hammer Action Negligible

As to (1): A bridge is rarely built with an appreciable sag. Camber reduces the load on a bridge, but as the curve of camber rarely has a radius of less than 3,000 ft., the centrifugal force due to which is only 2.7 per cent at a speed of 50 mi. per hour and 0.4 per cent at 20 mi. per hour, the effect can properly be neglected.

As to (2): Hammer action may be defined as the effect of a load applied so rapidly that the parts adjacent to the point of application of the load receive its full effect before any large proportion of the final stress reaches the more remote portions of the member under consideration. As will be seen later on, the effect of impact increases very rapidly with the rigidity of the striking body and the stiffness of the body struck.

A stress due to an applied load passes through a body with a velocity approximately equal to that of sound, which, in the case of concrete is at least 8,000 ft. per second. A truck wheel passing over an obstacle and striking a bridge floor will hardly exert its full effect on the floor in less than 0.1 sec. In that time the stress could be carried through a very long span. Following this reasoning it would seem that the only hammer action that could damage the floor of a bridge would

be due to explosives, collisions or break-downs. It would seem that the hammer action may be ignored in designing bridges.

Effect of Roughness of Road

As to (3): Impact due to the roughness of the road is the most important point under consideration.

An easy calculation will show that it requires about ⅛ sec. for a body to fall through the first 3 in. A truck moving at the rate of 15 mi. per hour will travel 33 in. in that time. It is safe, therefore, to consider that a truck passing over an obstacle at the speed mentioned strikes the floor with the velocity due to the height of its fall from obstacles. This height multiplied by the weight on the truck wheel is the kinetic energy of the load at the instant it strikes the bridge floor. The elastic resistance to the fall is composed of the compression of the tires, springs, etc., of the vehicle combined with the deflection of the bridge due to the load. This resistance is zero at the instant of contact with the floor, increasing at a rate which is sensibly uniform until the motion is arrested. The total work of the load consists of the kinetic energy mentioned above, together with the work done in overcoming this resistance, this work being equal to the product of the load into the total deflection of the bridge and of the springs, tires, etc., of the vehicle. The total work of the load must equal the total work of resistanc

The height of fall will be reduced by the amount the tires and springs recover between the time the wheel clears the obstacle and the instant the tire touches the floor. The recovery of the tires will be practically instantaneous. The recovery of the springs will be equal to the time required for a body to fall freely through a height equal to the amount of the compression of the springs multiplied by the ratio of the weight of the whole truck and load to the weight of the portion of the truck below the springs. It would seem that if the height of the obstacle is about 3 in. and the total compression of the tires and springs of the vehicle under full load is an equal amount, the actual height through which the vehicle falls before contact is made between the tire and the floor will not exceed ½ in., which makes the additional stress due to impact equal to 1.15 times the wheel load. If a truck wheel weighing 15,000 lb., moving at a rate of 15 mi. per hour, strikes an obstacle 3 in. high, the tire being 40 in. in diameter, the impact will lift the vehicle 3 in., producing additional stress on the bridge floor of 14,000 lb. due to impact.

As to (4): A load passing over a bridge has a dynamic effect on the bridge independent of the roughness or curvature of the roadway. This is due to the fact that the stress in any given member is increased from zero to a maximum in a certain limited time. At the instant at which the stress reaches its maximum it is increasing at a certain rate, which imparts a certain amount of kinetic energy to the member, which, of course, produces additional stress. In the case of short beam spans a load of 15,000 lb. moving at 15 mi. per hour will have an impact effect of 10 per cent on a 5-ft. span I-beam, decreasing to about 4 per cent on a 40-ft. span. In truss spans the stress increase due to this cause is rarely more than 2 per cent on counters and diagonals near the middle of the span and much less for other members.

It would, therefore, appear that for heavy trucks on highway bridges, Causes 1, 2 and 4 can safely be ignored, and that as to Cause 3 an obstacle 3 in. high is sufficient to provide for. As the duration of the impact does not exceed one-tenth of a second, it is sufficient to assume that only one wheel load is acting at a time, so that if bridges are designed for the specified load applied statically with an additional impact load of one specified wheel load plus about 20 per cent applied at whatever point on the bridge will produce a maximum stress in the member under consideration, ample allowance will be made for all impact stresses, and 20 per cent impact on all wheels will give a wide margin of safety.

If higher-geared trucks are built in the future, it will be largely because the roads are smooth enough to justify the increased speed. Excessive speed of a truck over a bridge of present-day design with 20 per cent impact factor on floor which has become rough is more likely to result in a localized floor-slab failure or damage to the truck istelf than in failure of a main member.

Service Test Methods and Record of Ties in Track

METHODS for conducting service tests of ties in track and for keeping records of the results are included in the recommendations of the Committee on Ties, American Railway Engineering Association, submitted at the recent annual convention. A brief outline of present practice, indicating non-uniformity in methods, observation and record keeping, appeared in *Engineering News-Record*, Mar. 17, 1921, p. 461, indicating the findings of the committee. It is stated, however, that the work of the Forest Products Laboratory is tending toward more uniform methods of reporting but that the principal criticism of the test section method is in often giving abnormal results, due to special selection of ties and unusually good maintenance. Briefly, the committee's recommendations follow:

Recommendations—In locating test sections, it is of importance that a piece of track be selected that has no switches and is not likely to be disturbed by new construction or abnormal rail renewals. All the test ties should be put in at once, or "out of face," as this accelerates the gathering of the information and without greatly increasing the expense, the good ties removed being used elsewhere. All the different kinds of ties should be installed, so far as possible, under the same conditions of curvature, grade and drainage.

Not less than 100 ties of each kind should be installed. If installed in multiples of 100, the percentages are readily obtained. If too few ties are put in, a few abnormal failures may make the test misleading. Each tie should be numbered and if a reliable record is kept in the office it scarcely seems necessary to mark the tie with the kind of wood or date of placing. The test sections should be marked by suitable monuments at each end.

Installation and records of the test sections should be under the supervision of an experienced technical man, qualified to make accurate observations and keep good records, so that the tests will be continuous and not affected by changes in the personnel. Regular inspection should be made at least once a year. Ties should not be removed from the test sections, except in emergencies, without the approval of the official responsible for the record and should never be destroyed until inspected by him or his representative.

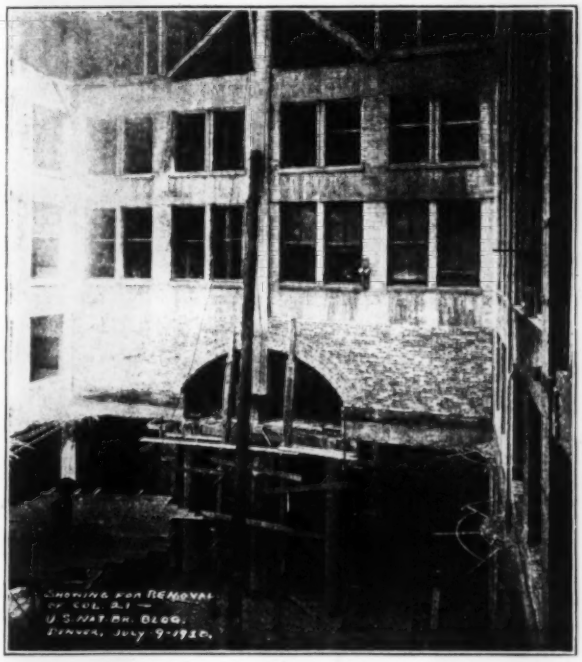
The essentials of the record are covered by two report forms: One giving the location and such data as traffic, weight of rail, kind of ballast, kind of tie, treatment, etc., and the other showing the conditions of each tie at each inspection. If many kinds of ties are under test in the test sections, a chart showing the location of the different kinds will be helpful. It is necessary to have a full record of the treatment of each different lot of ties under test.

Six Stories Added to Reinforced-Concrete Building

Connections of Old Four-Story Office Building to Ten-Story Extension Required Structural Steelwork

By Walter H. Wheeler
Consulting Engineer, Minneapolis, Minn.

REMODELING work of an extensive character was required in the erection last summer of the new United States National Bank Building at Denver, Col., a ten-story reinforced-concrete flat-slab structure erected on and around a four-story building of the same general design. It has sometimes been felt that the remodelling of a concrete building, and particularly of one with flat slabs, would be extremely difficult and

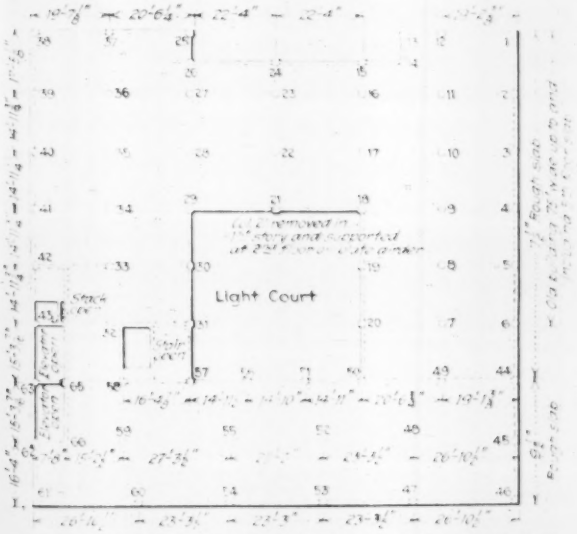


SHORING AND TEMPORARY BRICK ARCH UNDER COLUMN 21

Column 21 is shown cut off above the second floor and hanging free and upper part of first story column 21 is removed. Columns 21a and 21b are in place to receive new steel girder to support column 21 at second floor level. Old roof slab over light court shown removed.

expensive. In this case, however, the work was carried out expeditiously and economically, although some careful structural steel underpinning was required. It is of value, too, to note that the old building was of slag-aggregate concrete and that the embedded steel showed no signs of rusting.

The new building covers a ground area of 125 ft. square and is ten stories and basement in height with mezzanine in first story and a two-story pent house. Included in this structure is the reinforced-concrete frame of the old Century Building, constructed in 1908-09 by the Jones Wheeler Cranmer Engineering Co. on the Turner "mushroom" system flat-slab reinforced-concrete, with standard column capitals without depressions. The Century Building was 125 x 75 ft., four stories and basement with columns and column footings designed to carry four additional stories. The building was used for retail stores on the first floor and offices above. In one of the stores, under the wall of the east light court four cast-iron columns were used. The vertical column bars for these columns were concreted into the cast-iron columns and bent out at the



PLAN OF UPPER FLOORS OF REMODELED CONCRETE BUILDING

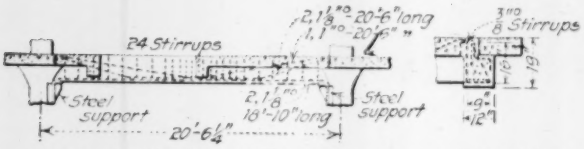
top for the slab reinforcing and the spandrel beam supporting the light-court wall was turned above the slab to eliminate the beams from the ceiling.

In the new building the ground area was increased to 125 ft. square and the whole structure carried up the full ten stories. The old columns and column footings were found to be safe for the extra stories, if hollow tile backing was used for the outside walls above the fourth story on the old part of the building.

The concrete in the old building was made from pit-run gravel, a considerable part of which was taken from the excavation for the old building. To bring up the percentage of coarse aggregate to the proper proportion, smelter slag was mixed with the gravel in charging the mixer and an excellent grade of concrete secured. The use of this slag was condemned at the time by some engineers, as they feared the sulphur might combine with the water used in mixing the concrete and form sulphuric acid which would attack the reinforcing. Chemical analysis of this slag convinced the builders that this danger was remote. The old steel exposed in remodelling the old building showed no corrosion. The concrete in the old structure was also found to be in very good condition, being sound and hard. The first floor slab of the old building was tested very severely by the building department during construction of the old building with what is known as the load, fire and water test, which it passed successfully.

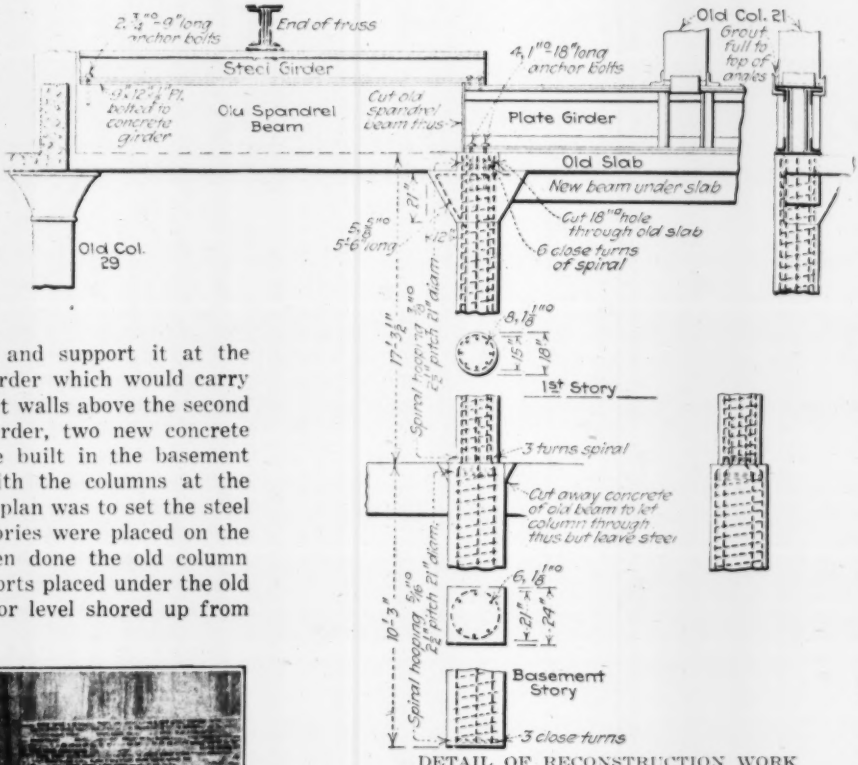
This test consisted of placing pig iron over a rectangular area at the center of one floor panel equal to more than twice the design load of the whole panel. A large wood fire was built under this panel with flame striking the bottom of the slab for 20 minutes and a fire hose then turned on the bottom of the slab. After the fire and before the load was removed the deflection was $\frac{1}{2}$ in.

In constructing the new building it was found neces-

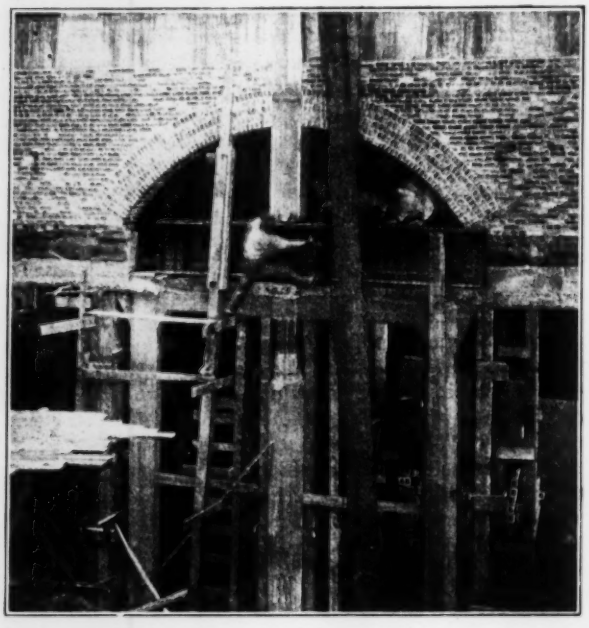


DETAIL OF BEAM SUPPORT OF JOINT BETWEEN OLD AND NEW FLOOR SLABS

sary to make extensive alterations in the old concrete structure to harmonize with the plans for the new building. The old concrete roof of the interior light court which is about 45 ft. square, was all removed and steel trusses placed spanning the light court to form a large central skylight over the banking room, about 30 ft. square. The roof of the skylight was raised to the level of the third floor, and the space around the skylight roofed over with a new concrete slab on a level with the second story window sills. One of the main columns (column 21 as shown in the plan) in the first story of the old building supporting the walls of this interior light court interfered with the plan of the banking room and it was decided to cut this column out in the first story and support it at the second floor level on a plate girder which would carry the nine slabs and the light court walls above the second floor. To support the plate girder, two new concrete columns of special design were built in the basement and first story to conform with the columns at the opposite side of the court. The plan was to set the steel girder before any additional stories were placed on the old structure. If this had been done the old column could have been carried by supports placed under the old spandrel beams at the third floor level shored up from


End of truss
Steel Girder
Old Spandrel Beam
Cut old spandrel beam thus
Plate Girder
Old Slab
New beam under slab
Cut 18" hole through old slab
6 close turns of spiral
Old Col. 29
Old Col. 21
Grout full to top of angles
1st Story
3 turns spiral
Cut away concrete of old beam to let column through thus but leave steel
Basement Story
3 close turns

DETAIL OF RECONSTRUCTION WORK AT COLUMN 21



SWINGING STEEL GIRDER SUPPORT FOR COLUMN 21 INTO PLACE

the basement. Delivery of the girder was delayed, so that in order not to hold back the construction of the building, arrangements had to be made for cutting off the old column and placing the girder under it after the floors above had all been poured and the forms for the roof and reinforcing for the roof in place. The load on the old column, including its own dead weight, which had to be supported while cutting off the old column and placing the girder, was about 130 tons.

The method used to support the old column and place the girder is shown in the views. Wood shoring was placed under the slabs around the old column from the basement floor to the fifth floor. Above the fifth floor the forms were left in place and reinforced with some additional shores. A temporary brick arch was built on top of the old second-floor spandrel up to the bottom of the third-floor slab to support the weight of the column itself and that part of the floor and wall loads which was not taken by the shoring. In cutting off the old column a hacksaw was used to cut out one of the vertical column bars and after the column was cut through and swinging free this section of the old bar was set back on the stub from which it was cut and it was found that the space between the upper end of this bar and the stub above was just equal to the width of the cuts made by the hacksaw, which indicated no settlement whatever in the old column. Much credit is due the contractors for the care with which they performed this delicate task.

The columns and footings of the old building along the line of connection with the new part of the structure were originally designed with a view to possible future extension of the building. The slabs along this line were built without spandrel beams, the floor load

and tile enclosing walls being carried solely by the slabs. No settlement was found in these slabs when the tile walls were removed, which would indicate that where this system of construction is used, the spandrel beams may be designed to carry a much smaller proportion of the floor and wall loads than has been the custom, or is permitted by building ordinances. To connect the new slabs to the old and support the joints shallow concrete beams were cast along the edge of the new slabs, and projecting half their width under the edge

CONNECTION OF NEW SECOND FLOOR SLAB TO OLD

Shows also connection of new second floor light court spandrel beam to old column, where old column capital furnishes support for this beam. Also steel channel in place for support of new floor beam along edge of old slab where new third floor slab joins old.

of the old slabs. These concrete beams were in turn supported by steel brackets carried on light steel channels strapped to the old concrete columns with steel bands, as shown in one of the views. It was not permissible to place new columns against the old columns or to increase the size of the old columns, as these are encased in marble of such a size that no margin was left to work in. Steel channels were selected of such a width that the flanges would fit around the face of the octagon columns by cutting a shallow groove in the old concrete column and allow the inner face of the channels to fit snug against the concrete face of the columns.

Where the spandrel beams of the inner light court connect with the old concrete columns, there was a full concrete capital on the old columns at the second floor, and above the second floor there were no capitals. The spandrel beams in the light court all turn above the floor slabs. To connect the new spandrels to the old columns heavy steel straps were placed around the old columns at the proper elevation to receive the hooked ends of the bent-up beam bars and pockets dug in the face of the old columns to receive these bars. To support the ends of the spandrel beams at the third, fourth and fifth floors, steel stirrups were concreted into the ends of the beams and these floors hung from the sixth-floor spandrels. These stirrups were buried in the walls of the light court to protect them against fire and corrosion.

To accommodate the stairway to the safe deposit vaults in the basement and also the main stairway from first to second floors it was necessary to remove one entire panel of the first floor slab and reconstruct it at two new levels. To support the edges of this new opening new concrete beams were cast under the old slab, some of these beams being supported on the old columns and others supported by and connected to old concrete beams in the first floor. The problem was complicated by the boiler breeching which was under this new slab and prevented the use of stub columns or walls for supporting this new slab. It was also necessary to move the stack and fill the old openings in the second, third, fourth and fifth-floor slabs and cut new openings in these slabs and place new concrete beams under the old slabs. At the second floor it was also necessary to provide a new opening for the main stairway. Above the second floor the stair is in the new part of the building. It was also necessary to fill quite a number of old openings in the first-floor slab, most of which had no beam framing around them. Wherever new beams were to be cast under old slabs, holes were cut through the old slabs at intervals and the concrete in the new beams poured through these openings.

To insure the required strength in the old cast-iron columns in the first story of the old building, they were encased in concrete and hooped with expanded metal mesh well lapped and tied. As these columns had been filled with concrete in constructing the old building the result of this operation was to produce hooped reinforced-concrete columns with cast-iron cores.

To support the new mezzanine floor in the first story of the old building, the diameter of the old columns was increased 4 in. from the first floor up to the mezzanine, and this casing of concrete was reinforced with ties and vertical bars. This method was permissible at this point as there was no marble casing to go on these columns, and the enlarged diameter is not an important consideration. Several of the old columns in the basement story under the mezzanine floor were also strengthened by a similar casing of concrete reinforced in a similar manner.

The general contractors on the work were the S. C. Lambie Co. of Denver. The architects for the building were W. E. & A. A. Fisher, of Denver, and the architects for the bank interior and vaults were Weary & Alford Co. of Chicago. The writer was consulting engineer on the reinforced-concrete and structural steelwork. The new part of the building is all Turner "Spiral Mushroom" system flat-slab construction with standard column capitals and no depressions. The spans range from 14 to 26 ft. The first floor is designed for 125 lb. live-load and the floors above for 70 lb. live-load per sq.ft.

The Prediction of Probable Rainfall Intensities

A Study Based on Records at Central Park, New York City, for the Fifty-one Years, 1869 to 1920—Proposed Curves for 5, 10, 15, 25 and 50 Years and a Proposed Maximum Curve

By Kenneth Allen
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In a paper presented to the American Society of Civil Engineers in 1915 Allen Hazen outlines the development and use of "probability paper" for forecasting the probable storage requirements of reservoirs. Applying this paper to the solution of rainfall problems the scales of ordinates and abscissas are so related that if x represents the percentage of years and y the intensities of rainfall the resulting curve for a downpour of a given duration is reduced to a straight line. Therefore if

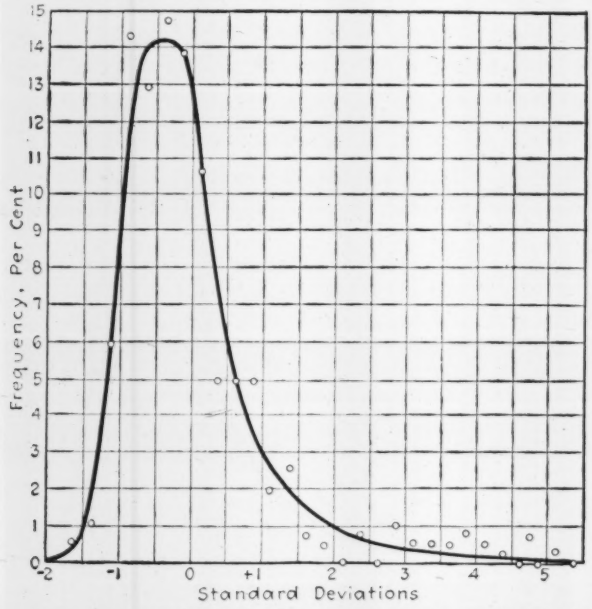


FIG. 1. RELATION BETWEEN STANDARD DEVIATIONS CORRESPONDING TO DIFFERENT RAINFALL INTENSITIES AND FREQUENCY OF OCCURENCE AS EXPRESSED IN PERCENTAGES OF YEARS

two points of the line are determined by observations extending over a comparatively short series of years the curve may be extended so as to serve for a much longer period. In fact, the period of forecast may be extended practically to infinity.

This "probability paper" is only applicable when there is an equal probability that an occurrence will have a value greater or less than the mean.

In throwing dice, in the distribution of raindrops on a small surface or in the deviation of the caliber of a gun from a true circle at different points of the circumference, the distribution of error above or below the mean will produce a symmetrical curve; but in rainfall intensities, wind velocities, expectancy of life, etc., there is a fixed limit to the departure of the minimum from the mean, while the departure of the maximum may greatly exceed this. Such distributions graphically expressed will therefore result in an unsymmetrical curve.

W. P. Elderton, in his treatise on "Frequency Curves and Correlation," classifies six typical curves of this kind, for which he deduces general formulas, and, following out his general method and those outlined by Harold G. McGee in an article on "A Diagram Adaptation of the Rational Method of Storm-Water Drain Design" (*Engineering News-Record*, Nov. 13-20, 1919, p. 868), the writer's assistant, W. T. Carpenter, has suggested and developed the series of curves of probable rainfall intensities shown herewith in Fig. 3. The method of developing these curves, being somewhat elaborate, is described hereafter in detail.

An unusually favorable series of intensity observations is available from the records of the self-registering gage established in Central Park in 1869 by Dr. Daniel Draper. This furnishes a nearly continuous record covering 51 years, from which the intensities for durations of from 5 to 120 minutes have been tabulated. From these records Table I has been prepared, giving the number and percentage of years in which a given rate of precipitation has not been exceeded. For instance, a rate of 3 in. per hour lasting 30 minutes was not exceeded in 45 years or 92 per cent of the 49 years in which 30-minute observations were noted.

With this table as a basis the several steps in the development of the intensity curves shown on Fig. 3 are as follows:

In order to simplify the matter we will first confine our attention to the 15-minute curve or to downpours of 15 minutes' duration. From the original tabulation (not

TABLE I. NUMBER AND PERCENTAGE OF YEARS IN WHICH CERTAIN MAXIMUM RAINFALL INTENSITIES WERE NOT EXCEEDED

	Duration in Minutes: 5		10		15		20		30		40		50		60		80		100		120	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1.0	..	..	..	..	..	..	..	..	..	..	3	7	6	13	12	26	7	32	7	37	8	50
1.5	..	..	..	..	..	..	2	4	9	18	18	39	30	65	34	74	20	91	18	95	16	100
2.0	..	..	1	2	4	8	13	26	28	57	36	78	41	89	43	93	21	95	19	100	..	..
2.5	..	..	4	8	15	31	31	62	42	86	43	93	43	93	43	93	21	95	..	..	..	..
3.0	6	12	18	36	30	61	37	74	45	92	43	93	43	93	44	96	22	100	..	..	..	..
3.5	11	22	29	58	39	80	44	88	46	94	43	93	45	98	46	100	..	..	..	..	..	..
4.0	19	39	38	76	40	82	46	92	46	94	45	98	46	100	..	..	..	..	..	..	..	..
4.5	27	55	40	80	43	88	48	96	47	96	46	100	..	..	..	..	..	..	..	..	..	..
5.0	31	63	43	86	47	96	48	96	47	95	..	..	..	..	..	..	..	..	..	..	..	..
5.5	35	71	47	94	47	96	48	96	49	100	..	..	..	..	..	..	..	..	..	..	..	..
6.0	41	84	48	96	47	95	49	98	..	..	..	..	..	..	..	..	..	..	..	..	..	..
6.5	44	90	48	96	48	98	49	98	..	..	..	..	..	..	..	..	..	..	..	..	..	..
7.0	46	94	48	96	48	98	50	100	..	..	..	..	..	..	..	..	..	..	..	..	..	..
7.5	47	96	49	98	48	98	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
8.0	47	96	49	98	49	100	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
8.5	48	98	50	100	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
9.0	49	100	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

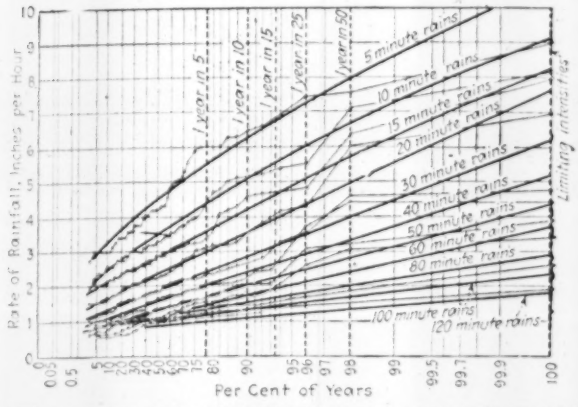


FIG. 2. PROBABLE PERCENTAGES OF YEARS IN WHICH A GIVEN INTENSITY OF RAINFALL, CONTINUING FOR A GIVEN NUMBER OF MINUTES, WILL NOT BE EXCEEDED

reproduced) it is seen that there were four years in which the maximum intensity varied from 1.51 to 2 in. per hour, the average being 1.98 in. Similarly, the average for 11 years having maximum intensities of from 2.01 to 2.5 in. per hour was 2.23 in. The sum of all these averages for the 49 years of observation was 152.68 in., giving an annual mean of 3.11 inches.

The "standard deviation"—hereafter referred to as SD—is then determined by finding the deviation from the above mean for each series of intensities, squaring, multiplying by the number of occurrences—hereafter designated as "frequencies"—adding the products, dividing by the number of years and extracting the square root.

Let m = the mean intensity in those years in which a given range of maximum intensities was observed.

M = the mean intensity for a given duration, determined as described above.

D = the deviation from M for the average obtained for a given intensity.

F = the frequency.

N = the number of years in the series.

Then

$$D = M - m$$

$$SD = \sqrt{\frac{F_1D_1^2 + F_2D_2^2 + F_3D_3^2 + \ldots + F_XD_X^2}{N}}$$

Thus, for 15-minute storms:

$D = 3.11 - 1.98 = 1.13$

$D = 3.11 - 2.23 = 0.88$, etc.

and

$$SD = \sqrt{\frac{(1.13^2 \times 4) + (0.88^2 \times 11) + \ldots \text{etc.} = 63.98}{49}}$$

$$= 1.144$$

The next step is to prepare a table of frequencies in terms of *SD*. Starting with the assumption that for M the value of D is 0, the intensities for each quarter of an *SD* above and below M are determined with their corresponding frequencies. This is illustrated in Table II.

To harmonize the resulting frequency curves for downpours of different durations, as well as to utilize as large a number of observations as possible, the average of all percentages corresponding to each assumed range of *SD* is obtained (Table III) and plotted as a dot on Fig. 1; and using these dots as a guide a curve is drawn in and so adjusted that the sum of the percents corresponding to ¼ *SD's* will equal 100.

This curve, unlike the normal "curve of error," is seen to be unsymmetrical, the *SD's* of appreciable magnitude extending from 2 below to 5 above the mean, with the "mode," or point of maximum frequency, corresponding to a *SD* of about —0.4. This lack of symmetry is characteristic of other natural phenomena, as already mentioned, probability curves for which can be worked out in a similar manner.

Assuming that this curve is tangent to, or cuts, the axis of x at —2.0 and at +5.0 — which for all intents and purposes is correct—the ordinates cutting off 1 per cent, 2 per cent, etc., of the area comprised between the axis of x and the curve to the left are located, and these ordinates, transferred with the axes of x and y to a clean sheet, furnish a "probability sheet" upon which we may then construct a series of curves indicating the percentage of years in which a given rainfall intensity will not be exceeded. (Fig. 2.)

Table IV gives the abscissas for the ordinates of the probability sheet corresponding to different percentages. The result of this spacing of ordinates is that if, for storms of a given duration, the rates are plotted on the ordinates corresponding to the frequency the line connecting these points will theoretically be straight. Therefore if but two points are determined by observations the line can be extended so as to cover an infinite series.

TABLE II. DISTRIBUTION OF ANNUAL MAXIMUM INTENSITIES FOR FIFTEEN MINUTES IN TERMS OF STANDARD DEVIATION

Standard Deviation	Intensity, In. per Hr.	Frequency, Years	Per Cent of Years
—1 25	1 69		
—1 00	1 97	1	2 0
—0 75	2 26	8	16 3
—0 50	2 54	7	14 3
—0 25	2 83	8	16 4
0 00	3 11	7	14 3
+0 25	3 40	7	14 3
+0 50	3 68	2	4 1
0 75	3 97	0	0 0
1 00	4 25	2	4 1
1 25	4 54	1	2 0
1 50	4 82	4	8 2
1 75	5 11	0	0 0
2 00	5 40	0	0 0
2 25	5 68	0	0 0
2 50	5 97	0	0 0
2 75	6 25	0	0 0
3 00	6 54	1	2 0
3 25	6 82	0	0 0
3 50	7 11	0	0 0
3 75	7 40	0	0 0
4 00	7 68	0	0 0
4 25	7 97	0	0 0
4 50	8 25	1	2 0
Total		49	100.0

In practice the actual frequency of each intensity is plotted. For example, for 15-min. storms with rates of from 1.51 to 2.0 in. per hour, there occurred one of 1.92 in. and 3 of 2 in. in 49 years. Therefore:

Plot intensity 1.92 on ordinate representing 1/49 = 2.0% of years
Plot intensity 3.00 on ordinate representing 2/49 = 4.08% of years
Plot intensity 3.00 on ordinate representing 3/49 = 6.12% of years
Plot intensity 3.00 on ordinate representing 4/49 = 8.16% of years

Continue this process with the 11 storms of from 2.01 to 2.50 in. per hour; 15 storms of from 2.51 to 3 in.

TABLE III. ILLUSTRATING METHOD OF COMPUTING AVERAGE FREQUENCIES CORRESPONDING TO STANDARD DEVIATIONS

SD =	—1.75 to —1.50 Per Cent	.... 0 to —0.25, etc Per Cent
5-min. storms	0	10 2
10-min. storms	2	10 0
15-min. storms	0	14 3
20-min. storms	0	6 0
30-min. storms	0	18 4
40-min. storms	2 2	8 7
50-min. storms	0	13 0
60-min. storms	0	4 3
Average	0 .5250	10 .6125

results in a line approximately straight. And this represents, to the nearest practicable degree, the probable frequency of 15-min. downpours (Fig. 2).

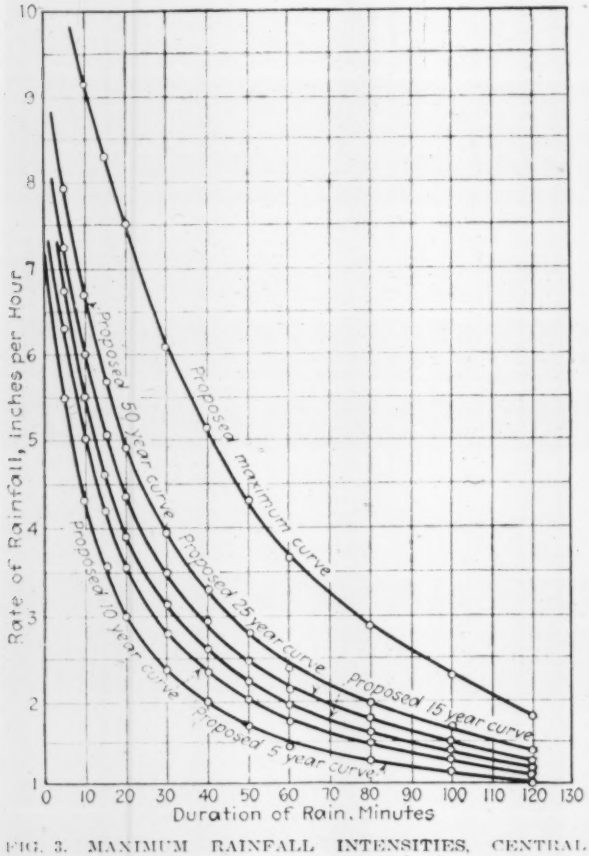

Rate of Rainfall, Inches per Hour
Duration of Rain, Minutes
Proposed maximum curve
Proposed 50 year curve
Proposed 25 year curve
Proposed 15 year curve
Proposed 10 year curve
Proposed 5 year curve

FIG. 3. MAXIMUM RAINFALL INTENSITIES, CENTRAL PARK RAIN GAGE, NEW YORK CITY, 1869 TO 1920

Loci platted from diagram, showing percentage of years in which a given intensity will not be exceeded.

From Fig. 2 the intensity curves shown on Fig. 3 are plotted for convenient use. For the 5-year curve, for storms not exceeded in 80 per cent of the years, the intensities corresponding to durations are taken from the ordinate marked 80; for the 25-year curve, or that for storms not exceeded but four times in a century, the intensities are taken from the 96 ordinate, and for storms which we may presume will never be exceeded the intensities are taken from the 100 ordinate, etc.

TABLE IV. ABSCISSAS FOR VARIOUS FREQUENCIES

Frequency.....	0.05	0.1	0.5	1	5	10	
Abscissa.....	0.298	0.386	0.670	0.810	1.178	1.385	
Frequency.....	20	40	60	70	80	90	
Abscissa.....	1.665	2.135	2.613	2.863	3.315	4.110	
Frequency.....	94	96	98	99	99.6	99.9	
Abscissa.....	4.740	5.240	6.105	6.950	7.910	9.020	100

These curves are in the usual form for convenient use. Their derivation is laborious and not readily grasped, but the actual work is not difficult, and having been once done need not be repeated.

The advantage claimed by the adoption of this method is that it is believed to furnish the nearest practicable approach to the true probability, and the ability to secure this with reasonable reliability without recourse to a very extended series of observations.

Practical Results in Piloting Ships by Electrified Channel Cables

PILOTING OF VESSELS through harbor channel in foggy weather by means of cables energized by audio frequency current has proven a success from the standpoint of navigation in practical tests and demonstrations of piloting ships by this means through the Ambrose Channel into New York Harbor according to a paper by A. Crossley, expert radio aid, Navy Department, Washington, D. C., before the Institute of Radio Engineers. The ships were equipped with special double coil receiving devices, each connected with collector coils rigged out from the opposite side of the vessel. The tests demonstrated that in single channel operation a single cable could guide ships entering and leaving a harbor on the proper side of the channel.

The New York Harbor cable was laid July, 1920, extending from Fort Lafayette to the Ambrose lightship, a distance of 16 miles, the work being accomplished in 6 hr., after three days had been spent in underrunning existing cables. The cable was charged by a 1 kw. Navy standard 500-cycle, 120-volt generator obtaining a current flow of 3.5 amp. with pressure stepped up to 400 volts by a transformer. The destroyer "Semmes" was selected for a public demonstration, equipped with double coil audible receiving device, registering different degrees of intensity on either starboard or port side according to the ship's relative position to the cable. In October, 1920, demonstrations were conducted for navigational interests. In one test, with the pilot house ports closed with canvas, Captain Battle, of the Cunard liner "Virgilia," after brief instruction, piloted the "Semmes" on the correct side of the channel at a distance of 50 yd. from the cable by obtaining a certain signal strength from the port coil.

In extension of the system it is proposed to pick up a cable further out at sea, aided by wireless direction signals, and follow it to the light vessel from which point, by means of stop-watch and speed charts, warning of approach to turns in the channel may be given to aid in following the cable. Many improvements are to be made in the design of electrical equipment and there is a demand for some kind of a visual device to indicate directly the location of the cable, development of which is now being undertaken by the New York Navy Yard. It is understood, upon completion of the New York experiments, that the Bureau of Lighthouses, Department of Commerce, will take over the work of installing and maintaining cables in the important harbors of the country. Arrangements are also being made by the International Communication Conference to internationalize the use of audio frequency cables as an aid to navigation.

While the total cost of the New York Harbor installation will not exceed $50,000, the hourly maintenance and operation cost per vessel held outside of harbors during inclement weather is so great that the installation would pay for itself very quickly.

Three wireless fog signals will immediately be installed at the entrance of New York Harbor through the Lighthouse Service according to the announcement of Secretary of Commerce Hoover. Each of the stations is equipped with an automatic radio set sending out signals continuously during fog or thick weather. They may be picked up on shipboard by means of the new radio compass developed by the Bureau of Standards

The compass indicates the direction from which the radio signals are sent out, and by taking observations on the different stations the captain of a vessel may determine his exact position without being obliged to rely on the former unsatisfactory method of locating the position of his ship by the sound and apparent direction of whistles and fog horns.

It is understood that radio signals will operate to aid ships in picking up the cable. The signals have been developed as the result of co-operative experiments by the Bureau of Standards and the Lighthouse Service, and more especially through the research work of the Bureau of Standards in improving the radio compass. Bearings from the compass can be determined without depending upon expert radio operators. The sending apparatus can be operated by regular light keepers without skilled personnel. The signals have been installed on Ambrose Channel and Fire Island lightships and at Sea Girt lighthouse, and will operate on a wave length of 1,000 m., the international standard for such signals. The Lighthouse Service plans to establish other stations near the entrances to the principal ports and at other important points on the Atlantic and Pacific coasts as rapidly as necessary funds are provided.

Tests Show Thin Solid Partition Best Sound Insulator

IN A SERIES of tests recently made by Prof. F. R. Watson, of the University of Illinois, in a specially fitted room so as to obtain comparable results, it was shown that greater sound insulation resides in a solid plaster wall than in one of so-called hollow block units of the same material and that a thin plaster wall on a metal lath base has the best insulating qualities of any of the types tested. The partitions tested were set up successively in a wall between two test rooms and the surrounding conditions maintained as constant as possible so that the only changing factors were the partitions themselves. An organ pipe under constant air pressure was placed on one side of the partition and the sound directed to the partition. The sound passing through was measured on the other side with a Rayleigh "resonator," an extremely delicate sound measuring instrument.

Tests were made on metal lath with plaster coating on one side only, on partitions having cracks in the walls and threshold clearances at the base of the doors, on 2-in. metal lath and plaster partition and 2-in. plaster board partition, and on 3-in. plaster block partition plastered on both sides, and 3-in. plaster block partition plastered on both sides with the air holes in the plaster block filled with plaster.

It was shown definitely that sound transmission increased with the size of the cracks in the partition of whatever sort and that the transmission under thresholds and around doors was quite large. The relative intensities of transmitted sound as measured by the different tests are expressed numerically as follows:

	Relative Intensities
2 in. solid metal lath and plaster partition...	0.93
2 in. plaster board and plaster partition.....	2.35
3 in. plaster block partition plastered on both sides with plaster filled in holes	1.16
3 in. plaster block partition plastered on both sides with open air holes.....	3.85

Prof. Watson states as a conclusion of the experiments that the transmission of sound through partitions is a complex phenomenon and that it is not a simple matter to judge the relative merits of partitions unless all the conditions are considered. Two partitions should not be compared in efficiency on the basis of quality unless the other qualities are the same. Thus a partition to which a coat of plaster is added will transmit less sound not only because of the increased weight, but also because it becomes more rigid. All the partitions in this test because of their weight stop a large part of the incident sound, though vibration of the walls played some part in the transmission, as shown markedly by the comparatively thin ½-in. partition. The thicker partitions because of their greater rigidity would have smaller amplitudes of vibration.

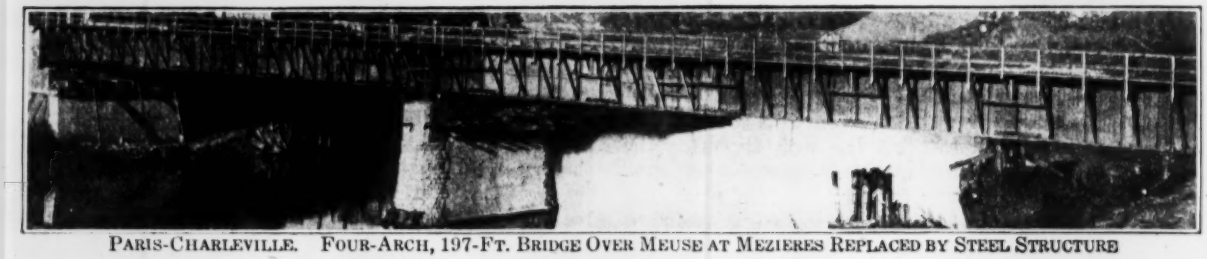
The superiority of the metal lath and plaster partition, according to the report, is doubtless due to several qualities. The metal lath core because of its open mesh not only allows the construction of a homogeneous plaster medium that is continuous from one face through the metal lath to the opposite face, but it also reinforces the partition. It has therefore a desirable quality of inertia with increased rigidity. The superiority of the plaster block partition with the plaster filled air holes over a similar partition with open air spaces would appear to be due to increased weight or inertia. Both of these partitions appear at a disadvantage because of the lack of homogeneous structure. Buttering the joints with plaster, particularly at the ends of the blocks, may not always insure continuity of plaster and thus leave possible cracks or channels through which sound may pass. This would also tend to weaken the partition compared with one in which the joints were completely filled.

Railroad Reconstruction in France

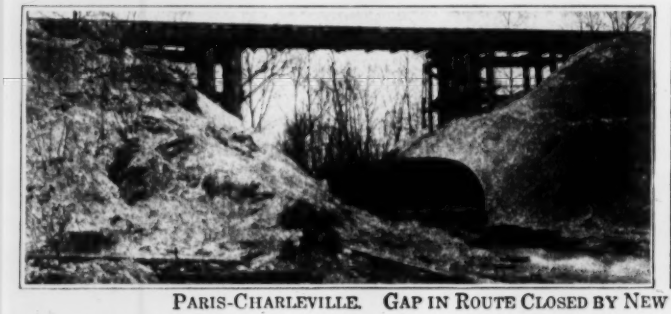
RECONSTRUCTION of the French railroads since the Armistice, according to a statement of the French Commission in the United States, progressed with such rapidity that the entire 2,404 km. of double-track line totally destroyed during the war have been completely rebuilt. Of the 2,785 km. of single-track line destroyed, 1,810 have been entirely reconstruced and opened to traffic, and work on the remainder is now being carried out. Some idea of the extent and difficulty of the work involved may be gained from the following two pages of photographs depicting typical reconstruction of bridges and destroyed lines.

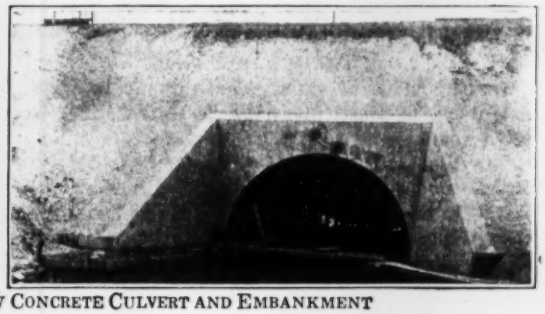
The work of electrifying certain French roads, which started in 1920, has made considerable progress. The Midi Company has 150 km. of double-track electric line in operation and the work of electrifying a further 3,000 km. of track belonging to this road is under way. The reconstruction of two hydro-electric plants, which will furnish 150,000 hp. each to this road, is nearly complete. The road has placed orders for 50 new electric locomotives of the type used by the Chicago, Milwaukee and St. Paul Ry. Two other French railroads have undertaken the elctrification of sections of their line, the Orleans, which is electrifying 3,000 km., and the Paris-Lyon-Mediterranée, which also is electrifying 3,000 km. of road. The electric power for the Orleans road will be furnished by the water falls of the Upper-Dordogne, and for the Paris-Lyon-Mediterranée by the falls of the French Alps. The cost of electrifying these roads will be in the neighborhood of 5,000,000,0000 fr.

After Two Years of Peace—*How France Has Repaired*

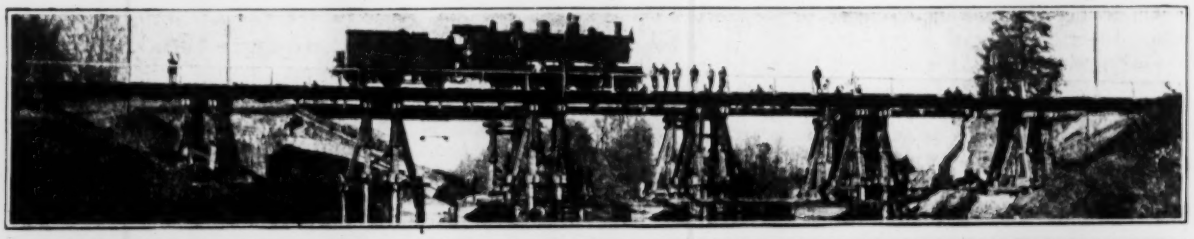


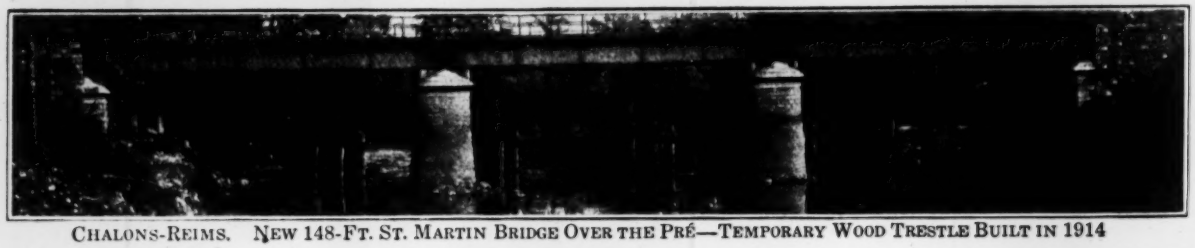
PARIS-CHARLEVILLE. FOUR-ARCH, 197-FT. BRIDGE OVER MEUSE AT MEZIERES REPLACED BY STEEL STRUCTURE





PARIS-CHARLEVILLE. GAP IN ROUTE CLOSED BY NEW CONCRETE CULVERT AND EMBANKMENT





CHALONS-REIMS. NEW 148-FT. ST. MARTIN BRIDGE OVER THE PRÉ—TEMPORARY WOOD TRESTLE BUILT IN 1914

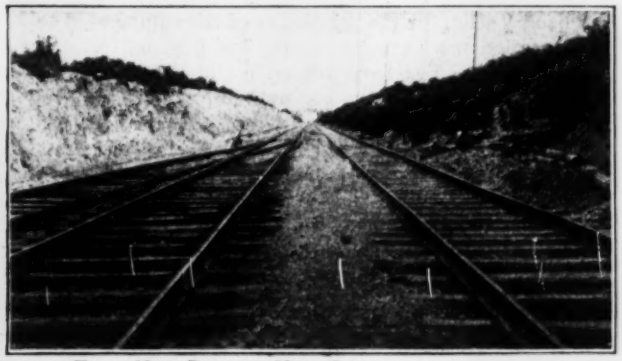
PARIS-STRASBOURG. CHALIFERT BRIDGE, SHOWING DEMOLITION IN 1914 AND RECONSTRUCTION; LENGTH, 230 FT.

War's Damage to Railway Bridges on Old Battle Front

REIMS-LAON. GUIGNICOURT BRIDGE, 216 FT., OVER THE AISNE REPLACED ON SITE OF WRECKED STRUCTURE

CHARLEVILLE-GIVET. 216-FT. BRIDGE AT MONT CY ON THE MEUSE, AS DESTROYED AND REBUILT

CHARLEVILLE-LONGUYON. AT LUMES ON THE MEUSE — TEMPORARY REPLACEMENT OF 295-FT. BRIDGE



REIMS-LAON. NO MAN'S LAND GRADED TO FORM NEW ROADBED NEAR LOIVRE

Engineering Education at Harvard

Industrial Co-operative Work and Course in Engineering Administration Features of Re-established School

MUCH interest was aroused in 1914 in the co-operative agreement between Harvard University and Massachusetts Institute of Technology by which the engineering work of Harvard was largely transferred to the institute's plant. This plan had to be terminated in 1917, due to a decision of the Massachusetts Supreme Judicial Court, which held that Harvard could not legally use the Gordon McKay bequest, the nucleus of the funds for the engineering school, in carrying out the agreement. The affiliation was therefore terminated and in the fall of 1919 engineering instruction was re-inaugurated at Harvard, the new school being styled the Harvard Engineering School.

Unlike its predecessor, which when the co-operation with the institute was inaugurated was a graduate institution, the re-established school is primarily an undergraduate engineering college, though larger provision is made than in other institutions for graduate and research work. It will be remembered that the Graduate School of Applied Science was, in turn, the successor of the Lawrence Scientific School, the original undergraduate college established in 1847.

In the re-established school four-year undergraduate courses are offered in mechanical, electrical, electric communication, civil, sanitary and municipal engineering; sanitry chemistry; mining, metallurgy, and industrial chemistry.

In addition, co-operation with the industries has been introduced as a variant for those who elect it in the four-year courses in mechanical, electrical, civil and sanitary engineering. There has also been established a five-year course in engineering administration.

Co-operative Instruction

Co-operative instruction was inaugurated last September. The students electing such work alternate between school, on the one hand, and industrial plants, public service companies, and engineering and contracting firms, on the other, during the third year of their course. This is provided for by a rearrangement of the courses and by the use of one whole summer's vacation and part of another, without increasing the number of years required to obtain a degree or diminishing the classroom instruction.

At the end of the second year the students are divided into two equal sections in June. One section studies from the first of July to the middle of August and has vacation for the remainder of the summer. The other section has vacation during the first half of the summer and studies from the middle of August to the end of September. At the beginning of the college year one section reports for classroom work for two months and the other section for work in the various industries for two months. The classroom work and outside work are then alternated in two-month periods from September to September, giving each student three periods of two months each in the industries and, including the work of the previous summer, a full year of college studies.

The industries in which the students are placed are selected in accordance with the preferences expressed by the students and with the character of the courses they are taking. The object of their experience is to give them a broad vision for business. To get this they are placed in three or four major departments and are given in advance a list of questions relating to the functioning of the department. In order to be able to answer the questions the students must cultivate a careful habit of observation, must ask questions in the shop and in the school, and must look up references. Finally they write a detailed technical report, accompanied by sketches and photographs, of some particular phase of the work. During the classroom period of the alternation, the students report at least twice a week to a class on industrial engineering and relate to their fellow students what they have learned on the job. As the other students may not agree with the statements, discussion follows. An instructor in industrial work is present in order to guide the students. The young men thus learn to think on their feet, to speak to their equals, and by combining their experiences with those of others in different lines of activity get a practical background with which the classroom work can be co-ordinated. It would be difficult to obtain such experience and co-ordination in any other way.

The industries of Massachusetts and nearby states are heartily co-operating with the school in this co-operative work.

Engineering-Administration

The new course in engineering administration is given jointly by the Engineering School and the Graduate School of Business Administration. It talks five years to complete, and includes all the scientific training given in the four-year programs in mechanical, electrical or civil engineering, or in mining or metallurgy, and also a well-rounded course of study in the fundamentals of business administration.

The first two years of the program are identical with the first and second years of the engineering courses; the third year is that of a student in engineering who elects the industrial work previously described, while the fourth and fifth years are devoted to concurrent instruction in engineering and business. During the last two years all the fourth year work of the regular engineering program is covered and a group of courses in business, which will include in substance all the studies of the industrial management group as offered by the business school, namely, the principles of accounting, factory management, shop accounting, marketing, industrial finance, business policy, labor problems, business economics, and a thesis on a combined engineering and business subject.

It is expected that these two groups of courses, together with the training acquired by means of experience in the industries during the work of the third year, will in five years give men who take these programs not only a thorough grounding in the principles of engineering science, but also sound training in business methods.

The buildings devoted to the use of the school include Pierce Hall, the Cruft High Tension Laboratory, the Rotch Building (for mining and metallurgy), and the new Gordon McKay Engineering Laboratory (for the larger engineering experimental and test equipment, such as gas, oil and hot-air engines, air compressors, hydraulic machinery, materials testing equipment, etc.). The latter is a one-story building with a floor area of about 30,000 sq.ft., erected for the use of the Navy

during the war and now transformed into a modern laboratory.

The registration in the school this year is 232, not including first and second-year engineering students who are registered in Harvard College, the relation between the school and the college permitting students of engineering to register in the college if they choose for their first two years.

Concrete Road Mix Proportioned at Central Plant

Clamshell Bucket and Belt Conveyor Load Bins and Three-Compartment Motor Trucks Deliver to Mixer

By H. T. Tuthill
County Assistant Engineer, New York Highway Commission, Sayville, N. Y.

A CENTRAL proportioning plant from which three-compartment motor trucks delivered aggregates and cement to the mixer prevented wastage of materials, facilitated the checking of the contents of each batch and insured continuity of construction operations on the concrete highway in Suffolk County, N. Y., built between Cold Spring, Huntington and Fort Solonga, a distance of 5.86 miles. In the design and layout of the plant the reduction of labor costs by the application of machinery was the chief consideration.

The pavement was 20 ft. wide, 8 in. thick at the

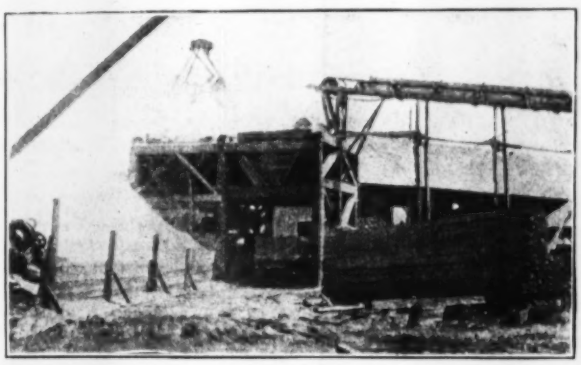


FIG. 1. TWO-COMPARTMENT HOPPER BIN FOR SAND AND STONE, SHOWING SAND CONVEYOR BELT

center and 6 in. thick at the sides with a parabolic crown. It was reinforced longitudinally with two ⅝-in. square twisted bars placed 6 in. from the edges and 2 in. above the finished subgrade. The mix was 1 : 1½ : 3. Transverse expansion joints of the premolded type, ½ in. thick, were provided every 33 ft. These joints were formed to fit the section of the pavement and extended from the base to within ½ in. of the top—in other words they were submerged joints. At the end of the day's run, joints ¾ in. thick were placed the full depth of the pavement. Finishing was done by the roller and belt method. Sand obtained locally and imported limestone were used.

Central Proportioning Plant—At the central material proportioning plant cement, sand and stone in their proper proportions were dumped into motor trucks having three compartments, each compartment holding a 5½-bag batch.

This plant was located on Huntington Harbor with

FIG. 2. THREE-COMPARTMENT TRUCK AFTER DISCHARGING FIRST BATCH TO MIXER SKIP

docking facilities to accomodate deep draft scows, all cement and stone being received by boat. Adjacent to the dock, where the bins were located, was a bank of sand of excellent quality.

The equipment consisted of a hopper bin (Fig. 1) divided into two compartments, one for sand and one for stone, in the bottom of which were six gates, three for sand and three for stone. These gates discharged into a measuring box divided into six compartments with trap doors in the bottom. This box was so arranged that a truck could drive underneath and when the doors were tripped, the batch compartments each received their proper proportion of sand and stone. The truck then moved on to the cement platform where each batch compartment received 5½ bags of cement. The truck then proceeded to the road to charge the mixer.

The hopper bins were charged with stone by a stiff-leg derrick and boom with 1 cu.yd. clamshell bucket. This outfit also unloaded the boats. It was capable of handling a 500-cu.yd. cargo per day. A 20-hp. three-drum hoisting engine operated the hoist and swinging gear.

Sand was delivered to the hopper bins by means of a belt conveyor mounted on a trestle. This trestle, erected on an incline, ran from the hopper to the sand pit and had at its center a clearance of 14 ft., providing sufficient head room for the passing of trucks as they swung in a circle to drive under the hopper. Power for the belt conveyor was furnished by an 8-hp. gas engine with chain-and-sprocket drive. In the sand pit, the belt was fed from a hopper being charged with sand by a crane operating a 35-ft. boom with ¾-cu.yd. clamshell bucket.

Cement in sacks, was unloaded from the barges by a mast and gaff rig through an opening in the roof of the cement shed. A 5-hp. gas engine furnished power for hoist with hand swing.

The force operating the plant was as follows: 1 superintendent; 1 engineer and 1 fireman on the stiff-leg derrick; 1 engineer, 1 fireman and 2 laborers on the crane and sand pit; 1 laborer operating the control gates at the hopper and loading trucks; 6 laborers unloading cement bags from barges, charging truck compartments (5½ bags to each compartment) and baling empty cement bags.

Transportation of Materials—Motor trucks with dump bodies (Fig. 2), each body being divided into three

compartments and each compartment carrying a 5½-bag batch of dry material, were utilized in conveying the batches from the proportioning plant to the mixer on the sub-grade. On arrival on the sub-grade the truck is turned around before reaching the forms set and is backed down to the mixer. The front end of the truck body is then elevated. Latches set in the floor of the truck and which secure the partition of the first compartment, are released and the first batch is

FIG. 3. SPREADERS AND FINISHERS AT WORK BEHIND CONCRETE MIXER

charged into the skip. The truck then moves ahead a few feet, the skip is elevated and the mixing drum charged. This operation is repeated until the three batches are discharged, the truck then returning to the mixing plant. An average of 10 trucks per day were used—five being of 3½-ton capacity.

The dead haul from the central proportioning plant to the highway under construction was 1.5 miles over roads which were in good condition. The average haul on the construction was 1.75 miles making a total average haul of 3.25 miles. Heavy up-hill hauls were encountered on the highway under contract, the percentage of some of these grades being as follows: 350 ft. of 8.77; 250 ft. of 8.35; 775 ft. of 5.00; 260 ft. of 7.7; 300 ft. of 5.7; 335 ft. of 7.0. A number of soft sandy spots in the subgrade also made hauling difficult on the contract.

Mixing and Placing Concrete—The equipment and labor for mixing and placing concrete is indicated below:

Equipment

One 5½-bag batch mixer, caterpillar tread, gasoline motor, chute discharge.
1,000 ft. of forms.
3,000 ft. 2-in. pipe.
One water pump, triplex, 6 to 8 hp., 50 gal. per minute.
Quantity of rubber hose.
One hand roller.
One screed, 22 ft. x 12 in. x 3 ft., cut to crown of road.
One 8x4 in. x 22 ft. belt.

Force at Mixer

1 foreman.
1 engineer } Operating mixer.
1 oiler }
2 laborers, screed, roller and belt.
3 laborers, spreading concrete.
2 laborers, dumping trucks.
2 laborers, trimming sub-grade ahead of mixer.
2 laborers, covering pavement.
1 laborer, brooming pavement surface and wetting down.
3 laborers, form setting.
1 engineer, water pump.

A daily record of the lineal feet of pavement 20 ft. wide placed during the period from June 10 to Sept. 11, 1920, is shown in the accompanying table, which includes maximum and minimum hauls.

Summing up the advantages derived in this method of operation, it was noted that there was no wastage of materials as is the case when materials are distributed along the roadway; the cleanliness with which the materials were maintained and the uniform production resulting in a finished product that was of excellent quality. Compression tests of 6-in. tubes which were made from the matrix developed breaking strengths averaging over 4,000 lb. per square inch for 28-day tests.

The saving alone in the preservation of empty cement bags was marked, as the system enabled the contractor to concentrate the empty bags at one point under cover and to return them on the return trip of a barge to the mill. The mechanical handling of the cement also constituted a great saving.

Continuity of operation enabled the contractor to increase his production. The plant could have easily taken care of two or more concreting outfits had the contractor chosen to operate them on the road. Simplicity of checking the proportioning of materials in a batch enabled the contractor to keep a close record of quantities used. The plant was portable and could be moved quickly to any railroad spur or dock and set up.

PROGRESS OF WORK

Date	Lin Ft.	Date	Lin.Ft.	Date	Lin Ft.
June 10	320	July 13	158	Aug. 14	360
June 11	323	July 14	222	Aug. 16	300
June 12	341	July 15	274	Aug. 17	343
June 14	342	July 16	328	Aug. 18	189
June 15	328	July 17	310	Aug. 19	230
June 16	343	July 19	240	Aug. 20	289
June 17	358	July 20	338	Aug. 21	329
June 18	396	July 21	245	Aug. 23	309
June 19	352	July 22	285	Aug. 24	97
June 22	257	July 23	270	Aug. 25	366
June 23	284	July 24	277	Aug. 26	387
June 24	383	July 26	377	Aug. 27	340
June 25	425	July 27	368	Aug. 28	349
June 26	333	July 28	375	Aug. 30	362
June 28	147	July 29	381	Aug. 31	364
June 29	148	Aug. 2	375	Sept. 1	319
June 30	230	Aug. 3	404	Sept. 2	409
July 1	312	Aug. 4	428	Sept. 3	497
July 3	285	Aug. 5	494	Sept. 4	352
July 6	195	Aug. 7	331	Sept. 7	338
July 7	280	Aug. 9	187	Sept. 8	394
July 8	325	Aug. 10	370	Sept. 9	423
July 9	128	Aug. 12	257	Sept. 10	310
July 10	55	Aug. 13	294	Sept. 11	260
July 12	142				

Total days, 73. Total lin. ft., 22,536. Av. per day, 309 ft.

My general observations have been that each road contract presents a problem in itself which has to be studied; a plan of operation successful on one job may not be at all adaptable or practical on another. The system described above, I consider, is governed largely by hauling conditions, although with the use of lighter trucks the obstacles of hauling could be reduced to a minimum.

Hayti-Santo Domingo Mails Carried by Airplane

United States Marine Corps aviators are engaged in scheduled mail carrying between Hayti and Santo Domingo, the two halves of the Island of Santo Domingo in the West Indies. On the map these two countries do not look far apart, but actual communication between the cities is very difficult on account of the bad topography, lack of roads and hostile natives. It is currently reported, for instance, that it takes a week to ten days to get from Port Au Prince to Santo Domingo. The Navy and the United States Coast and Geodetic Survey both have representatives in the island, and communication between them is being carried on by Marine Corps Aviation service. In addition, officers and officials are using the plane for inter-city travel. Trips which formerly took days are now accomplished in a like number of hours.

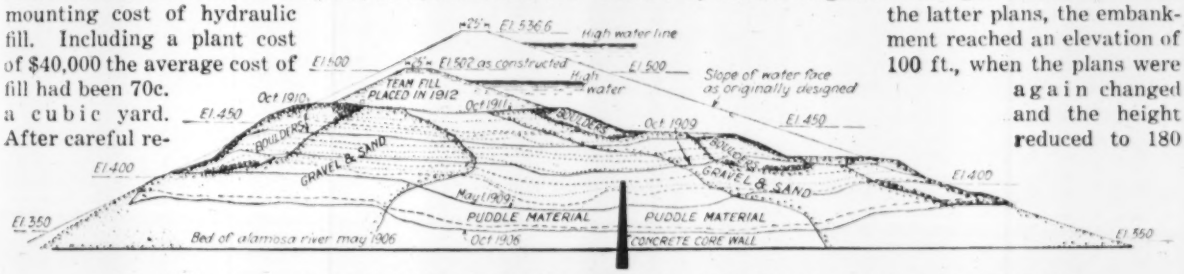
Hydraulic Fill Practice on Terrace Reservoir Dam

Details Given of Construction of Earth-Fill Dam—Studies of Flume Lining Place Cast-Iron Plates First and Green Spruce Blocks Second in Durability

By John E. Field
Consulting Engineer, Denver, Colo.

EXPERIENCE with several forms of sluice construction for hydraulic fill, in building the Terrace Reservoir dam in Southern Colorado, gave information of exceptional value on operating grades, lining wear and sluice efficiency. Incidentally important lessons in borrow-pit development were disclosed. This information has never been published. The main facts, it is, therefore, thought, are worth recording permanently even though they relate to an operation completed some years ago.

A description of the Terrace Reservoir dam and of the hydraulicking operations as of Nov. 1, 1906, was published in Transactions American Society of Civil Engineers, Vol. LVIII. June, 1907, pp. 237, 274. Construction was abandoned in October, 1907, because of the mounting cost of hydraulic fill. Including a plant cost of $40,000 the average cost of fill had been 70c. a cubic yard. After careful re-planning, operations were resumed. Sluicing was carried on 1909, 1910 and 1911 when the flood of October, 1911, destroyed the headworks, and much of the channel of the power canal. The plans submitted in 1908 called for the finishing of the upper 20 ft. of the fill by teams, as tests of borrow pits showed that there would be no material available for sluicing for that portion of the dam. The dam was completed in 1912 by teams, the upper 30 ft. being so placed at a cost of 40c. per cubic yard, the volume being 54,000 cu.yd. The team fill was surfaced with two feet of gravel and heavy boulder riprap.



PROGRESS CROSS-SECTION OF TERRACE DAM SHOWING LOCATION AND CLASS OF MATERIALS

The reservoir has been in use since 1911 and has given considerable trouble, viz., the discs of the outlet valves broke twice and the stored water was lost; a leak near the contact between the hydraulic and team fill caused the lowering of the water, and required the construction of a cut-off trench and puddle core; the steel pipe leading from one of the valves was torn out by the high velocities of the water, and difficulties arose due to misunderstandings with owners of older direct flow water rights, and lack of funds. It is believed that the troubles are past as in 1920 good service was had. The writer has recommended the expenditure of some $25,000 to install a duplicate set of control valves in the tunnel, as the two 4-ft. circular valves are difficult to operate, and whenever out of order, cannot be repaired without emptying the reservoir. Resumption of the work was undertaken on the basis of an estimate by the engineer that, exclusive of plant engineering and interest on investment, the fill would cost 15½c. a cubic yard.

Terrace Reservoir, is located on the Alamosa River, a tributary of the Rio Grande in Colorado. The drainage area is 125 sq.mi. The annual average discharge is about 120,000 acre-feet; the minimum flow is 20 cu.ft. per second, and the normal maximum flow is 1,500 cu.ft.

The reservoir was built for a supplemental supply of water to some 30,000 acres in the San Luis Valley, five miles below.

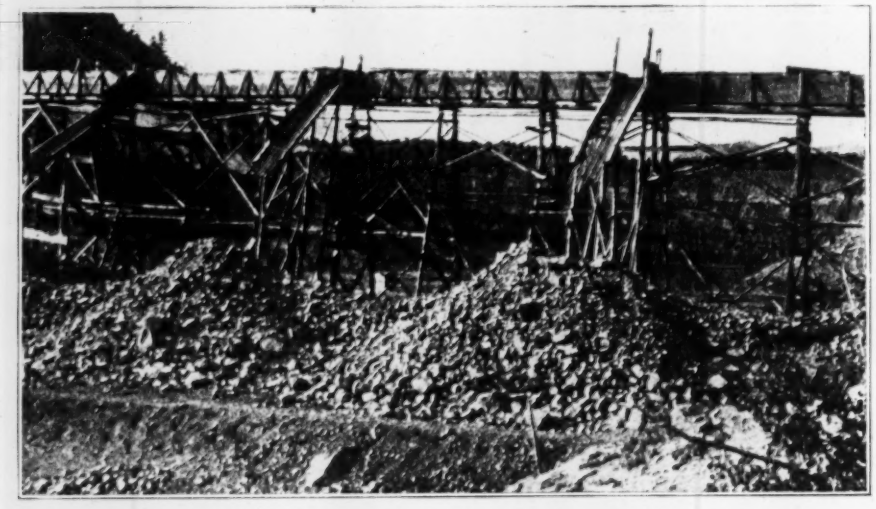
Plant construction was completed in 1905 and sluicing was begun in April, 1906. Sluicing was first suggested by the late T. W. Jaycox, and the late J. D. Schuyler was consulting and designing engineer until 1906. The first plans called for a dam 180 ft. above the river bed, and the height was changed to 225 ft. Under the latter plans, the embankment reached an elevation of 100 ft., when the plans were again changed and the height reduced to 180 ft. The dimensions pertaining to the reservoir are as follows:

Area covered at high water, acres	300
Depth of water	152 ft.
Height above present river bed, upstream side	157 ft.
Present river bed to old river bed	15 ft.
Lowest foundation below old river bed	45 ft.
Total height of dam	21.70 ft.
Length of crest	500 ft.
Length of bottom	75 ft.
Upper slopes about, including benches	1 on 4
Lower slopes about	1 on 2
Thickness at base	1,075 ft.
Width of crest	20 ft.
Capacity at high water, acre feet	16,800

In March, 1909, the fill had an average elevation of approximately 70 ft. above stream bed; some 200,000 cu.yd. had been placed on slopes of 1 on 2 and 1 on 3. Little rock material had been sluiced, and the embankment consisted almost entirely of sand outside the core, which, should the settling pool overflow or break, would wash very badly. Seepage from the settling pool would also cause sloughing. The lack of coarse material subjected the surfaces to the action of wind and rain, and required extra expense for riprapping the upper face. Water in the reservoir, and in the river below the dam, was eroding the toes and the presence of cedar and pine boughs and small trees in the slope indicated a tendency of the lower toe to slough. To correct these conditions rock was blasted from the side walls of the canyon, and the lower face riprapped in this manner. Rock was blasted also and dropped into the river some 500 ft. below the dam and the pool so formed soon filled with gravel, sand and silt. At the end of the work the tunnel entrance was closed and the water, if the plan outlined has been followed, is now taken in at a point

25 ft. above the tunnel level, the intention being to allow the old river channel to fill with fine material and seal up the old river bed against seepage, or at least to increase the distance water must travel in passing underneath the dam. About 25 ft. of fine material deposited over the old river bed for a distance of probably 500 ft. upstream seemed so superior to any other method of guarding against underflow that it was unhesitatingly adopted, especially as it involved little extra expense.

In case of hydraulic fill dams the waste water should be discharged into the reservoir basin, where a second and larger settling pool might be provided, and the whole area of the basin adjacent to the dam be coated with the finest and most impervious material. This especially should be done where fines are deliberately wasted in order to secure coarser and better drained puddle. The precautions and work mentioned had the effect of lowering the height of the dam above the river bed, and the discharge of waste water into the reservoir basin had the effect of sealing to a considerable extent the moraine deposits forming the lower end and sides of the reservoir, and since the reservoir has been in operation this rim has been further tightened and the escaping water materially reduced. Their average distance was about 2,000 ft. from the center of gravity of the pits to the center of gravity of the fill.



FLUME LINE WITH SIDE CHUTES, SHOWING TOE MATERIAL

The power canal was 7½ mi. long. Its capacity was nominally 30 cu.ft., but 20 cu.ft. was the practical safe capacity. This canal was built in 1904 at a cost of $36,000, and was not intended to be used for more than two years for construction purposes. During the last three years it was in use breaks and slides compelled the construction of more than half a mile of new flume, and the reconstruction of practically all the original flume at least once. At the end of the power ditch there was a penstock from which a steel pipe 15 in. in diameter led to the borrow pits, where three branches of 10 in. pipe led to the three monitors, two of which were used simultaneously.

Labor consisted of Americans for bosses, foremen, head carpenter, blacksmith, etc. The monitor men were generally pure blood Indians. Their intelligence was surprising, and their power of observation and imitation almost Oriental; they were methodical, reliable and apparently did not mind ice water spray in the least. The common labor was Mexican. Nearly all this labor remained steadily to the end of the sluicing in 1911.

FLUME LINE AND BORROW PIT

Terminal moraine deposits containing 15 to 25 per cent of rock ½ cu.ft. to 3 cu.ft. in volume, with occasionally masses of rock in excess of 1 cu.yd., furnished the embankment material. The pits ran fairly uniform, but occasionally a belt containing much larger quantities of rock would occur. The material left in the pits contained the large rock and also much sand and small rock. About 15 ft. seemed to be the limit of the depth to which the excavation could be carried as the accumulated debris rendered impracticable the securing of much good material at greater depths. Efforts were made to sluice to bedrock, and while this could generally be done it was very expensive. Shooting of the larger rock was tried, but had so little beneficial effect that it was abandoned. The rock was granite and trap, and the sand was quartz, trap and other igneous materials. The fines consisted of glacial slimes, extremely fine sands and a clay material. When damp this mixture had the appearance and the characteristics of clay. It settled almost completely, leaving only a slight turbidity.

To ascertain the best character of lining for the flumes different kinds were placed in the first flume built, which was 600 ft. long, and on a grade of 4 per cent, which reached a borrow pit that had been worked over superficially and contained large amounts of the smaller gravel, 1.6 in. and under in diameter. This flume was 2-in. material, 2 ft. wide on the bottom and 2 ft. deep, with vertical sides. An extra 2 x 8-in. plank was nailed to the sides to hold firm the paving with which the bottom was lined, and to prevent wear on the sides of the flume itself. The linings employed were 200 lin. ft. of 18 x ⅜-in. x 12-ft. high-carbon steel plates; 100 lin. ft. of 18 x 18 x ⅞-in. cast-iron plates and 300 ft. of wooden blocks.

Of the 300 ft. of wood block paving about one-third was cut from dimension lumber sawed at a near-by mill; the other two-thirds was a mixture from newly cut red spruce, pine and quaking aspen trees, and from logs which had been cut more than a year and had become dry. The blocks were roughly hewed to octagon shape and to dimensions determined by the size of the log from which they were sawed. The different classes were at first segregated and placed in different sections. Later, in placing blocks in new flumes and in making repairs, they became mixed. However, it was observed almost at once that the sawed dry lumber wore very rapidly; that dry logs also wore rapidly, but being largely of spruce, and not so dry, gave better service than the dimension lumber. The blocks from sustaining the wear due to the passage of more than 60,000 cu.yd. of material. About 12,000 ft. bm. costing about $400 in place in 1,000 ft. of flume indicated a cost of paving of about 3c. per cubic yard per 1,000 ft. of flume.

While the wood block lining was new the efficiency was good and there was little difficulty from clogging. After the blocks became rough the largest rock moved less readily, but the other material gave no greater trouble; in fact the sand, which ordinarily gave the greatest trouble, seemed to be held in suspension fully as well, if not better. The upward currents produced by the concavity of the blocks seemed to keep the sand stirred up and it was swept along with the current. The paving was laid in sections about 6 ft. long and

TABLE OF COSTS OF SLUICING AT TERRACE RESERVOIR DAM

1909	Power Canal	Pipe Line	Sluice Flumes	Dam	Storm Flume	Engineering and Camp	Total	Cubic Yards	Cost per Cubic Yard
April	$353	.....	$80	$36	$1959	$663	$3,091		
May	2,562	.....	2	19	408	725	3,716		
June	1,453	$347	1,804	527	99	840	5,067	5,000	$1 01
July	1,148	228	1,986	2,133	214	252*	4,957	15,000	0 33
August	470	82	1,475	950	.....	416	3,393	23,000	0 147
September	562	22	960	6M	.....	410	2,645	37,000	0 072
Total	$6,545	$679	$6,307	$4,356	$2,680	$2,302 * Credit	$22,869	80,000	$0 287
1910									
March	$43	.....	$4	$2	$126	$554	$729	.....	.....
April	615	$96	776	288	190	303	2,269	.....	.....
May	655	16	561	1,394	.....	357	2,983	20,000	$0 149
June	294	27	570	1,627	.....	295	2,845	17,000	0 167
July	399	32	292	1,641	.....	131	2,659	18,000	0 147
August	312	118	122	2,294	.....	332	2,977	20,000	0 149
September	215	16	400	1,561	.....	332	2,524	40,000	0 063
October	60	24	289	1,562	.....	406	2,341	16,000	0 146
Credits	.....	.....	.....	1,700	.....	700	.....	.....	.....
Total	$2,594	$329	$3,014	$8,669	$316	$2,005	$16,927	131,000	$0 130
1911									
April	$374	$82	$396	$614	$131	$191	$1,788	.....	.....
May	295	53	1,521	2,192	60	326	4,444	21,500	$0 206
June	254	271	490	2,175	50	386	3,626	16,700	0 217
July	321	...	1,378	1,795	144	503	4,141	9,000	0 460
August	325	1 2	1,421	1,935	.....	460	4,304	28,500	0 151
September to December	231	241	1,167	2,256	.....	1,100	4,996	31,800	0 157
Credits	.....	.....	.....	1,800	.....	700	.....	.....	.....
Total	$1,801	$806	$6,373	$9,167	$385	$2,267	$20,799	107,500	$0 195
Total 1909-1911	$10,940	$1,814	$15,694	$22,192	$3,381	$6,574	$60,595	318,500	$0 190
Cost per cu.yd	0 034	0 006	0 050	0 070	0 010	0 020	0 190	.....	.....
Per cent of cost	18 3	3 0	25 8	36 6	5 5	10 8	100	.....	.....
Plant and equipment	$18,000	$1,200	.....	.....	.....	.....	.....	.....	.....
Cost per cu.yd	0 056	0 004	.....	.....	.....	.....	.....	.....	0 060
Total per cent of cost	36 2	3 8	19 7	27 7	4 3	8 3	100	.....	.....
Materials	$1,276	$105	$5,532	$2,824	$996	$1,456	$12,189	.....	$0 038

Total average cost, including plant and equipment, $0 25 per cubic yard.

newly-cut timber were best, and of the varieties of tree the red spruce wore best of all.

The steel plates were worn through near the ends after the passage of about 50,000 cu.yd. of material as measured in the dam. The cast plates had worn very little after more than 100,000 cu.yd. had passed over them, but a considerable portion had become broken by that time, and the rest were discarded. The maximum wear on these plates was ⅛ in. in the center of these plates. The original cost and the impossibility of salvaging the broken plates, the work being some 25 miles by wagon haul and 150 miles by rail from the nearest foundry, militated against their adoption.

In the center of the flumes the wood block paving lasted until the construction of a flume at higher elevation became necessary, when it was discarded. The blocks along the sides and not so much worn were used in the new flumes, the worn surface being turned down. The first set of green spruce blocks, with some replacements, lasted throughout the operations of the 1909 season, when 80,000 cu.yd. were placed in the dam. These spruce blocks were, on the average, capable of 2 x 6-in. plank were used to separate the sections so that should a block become dislodged in any section the loss of paving was confined to that section. The blocks were simply wedged in tight and held down at the edges only by the 2- x 8-in. wearing planks on the sides of the flume. Three lines of flumes were built on the dam, aggregating 3,000 ft., and three from the borrow pits to the dam, aggregating 5,700 ft., and the total cost was $15,694, or $1.80 per ft. Of this $5,532 was for material purchased, and the balance was for labor, which included the sawing and hewing of most of the paving blocks.

In general sluicing started May 1 to May 15, and continued to Oct. 1 of each year. An average of ten hours' active sluicing was the rule in the two shifts, and often the third shift was used in "ground sluicing."

In "ground sluicing" furrows were plowed, or small canals were dug, on the steep hills outside of the areas available for the monitors, and the water washed the dirt from these slopes down to the borrow pits proper, where the coarser material and sand were dropped. The fine material was carried through the flumes to the

dam and built up the puddle core. This operation was usually employed when the core was becoming too contracted and not enough fines were being secured by the monitor operations. The sand deposited in the borrow pits was later picked up by the monitors and sluiced to the dam in the regular way.

Determination of minimum grades was accomplished by first building a flume on a 4 per cent grade. This worked very satisfactorily, with almost no tendency to clog. The flume was new and carefully built to line and grade with easy curves and no angles. The second flume constructed was designed for a 3 per cent grade, but in building it 2.9 per cent was shown by the levels. This flume clogged badly whenever the amount of water decreased or any excess of material, especially sand, was driven into it, but where skilled operation of the monitors was secured—that is, a nearly uniform quantity of water, and of solids with proper proportions of silt, sand and boulders—the clogging was avoided. A grade of 3 per cent was adopted as the minimum allowable as a result of experience with this flume.

Boulders in the flume created cross-currents and upward currents that kept the sand in suspension and swept it along. It was found that where clogging impended throwing in round boulders 4 to 8 in. in diameter had the effect of cutting out the sand on the bottom of the flume and often would relieve the congestion. Generally, however, the flume men would shovel vigorously, stirring up the sand, and causing it to be swept away from the congested section. In the flumes rock weighing 100 lb. were readily carried; some rocks weighing 200 lb. were carried, but help was needed from the flume men.

During the first year's operation screens were used to separate the rock from the other materials. In 1910 and 1911 they were not used and two men on the toes did all the work necessary to dress up the slopes and prevent the water from flowing outward instead of into the settling basin. These men also attended to directing the water to the proper points.

In building the flumes across the dam material was discharged from the end of the uncompleted flume, a cone being built up on which the bent for the next section was placed and the flume extended until it was entirely across the dam. Material was then discharged, principally from the end of the flume, until the toe was raised to a little above flume bottom, when the end section was taken down and the process repeated. During this "breaking back" process material was discharged from the sides of the flume where and when advisable, there being a gate in each section of 15 ft.

Two waste wells and sometimes four were provided, the waste water being drawn through the one farthest from the point of discharge. The wells were connected with a horizontal box through the toes of the dam and consisted of four 4 x 4-in. posts to which planks were nailed whenever it was desired to raise the water in the settling basin. When the sand and gravel encroaching on the settling pool reached beyond the well, it and a part of the outlet box were removed, the portion of the box remaining through the toes was plugged and filled with boulders, sand and puddle material. A new box was then built over the toe of the dam and framework for the new well erected.

It is interesting to note that when 15 cu.ft. per second of water was being run in the flumes, the velocity was 20 ft. per second (surface velocity), but when solids were being carried, the velocity dropped to 15 ft. per second.

The percentage of material carried by the water was very small, about 1,500 cu.yd. per day was considered a very creditable accomplishment. The net amount of water used in sluicing was about 450 acre-feet per month, or 756,000 cu.yd., or the percentage of solids to water was 5½ per cent, as a maximum on a single month's run. Generally, the amount of solids was about 3 per cent, of which, from numerous tests, one-third was puddle material. Under similar conditions, and with similar materials, it would be unsafe to assume more than 5½ per cent solids, even where water was scarce, and would be carefully conserved and handled.

Had it been possible to put the sluice flumes on a 5 per cent minimum grade much better results would have been obtained; the flume men could have been dispensed with; the monitor men could have driven in a greater per cent of solids without clogging, and the necessary and added expense of securing every possible yard of material from the borrow pits would have been avoided, as the borrow pits could have been excavated to greater depths.

The proportion of boulders, gravel, sand and puddle in the dam was never determined, but the boulder section on both faces is in excess of 50 ft. at every point. A section of the dam, with the different classes of material indicated, is shown by the drawing. The boulder section is composed of material in excess of 3 in. in diameter, the interstices, however, being filled with gravel and sand. The gravel section is composed of material less than 3 in. in diameter. The sand is material which would pass a ¼ in. mesh screen, and was deposited at the edge of the settling pool. The boulders were deposited on a slope of about 1 on 3, the gravel on a slope of 1 on 10.

Cost Data

In the accompanying summary of costs the item Power Canal includes repairs and the wages of ditch walkers. It is probable that those items are too low, as in the numerous emergencies materials and labor charged to sluice flumes and dam were used on the power canal. Pipe Line includes the expense of moving and maintaining the monitors and pipe lines; Sluice Flumes includes construction and repairs; Dam is the expense of sluicing and includes wages of monitor men, sluice flume tenders and other work pertaining to the placing of materials on the dam; Storm Flumes is the expense of protective work against floods, the principal item being the building of the storm flumes; Engineering and Camp includes engineering and other camp expenses, loss on commissary, boarding house, etc.; Plant and equipment, consisting of the power canal and pipe line, was built by contract for $63,000, and it is said to have yielded a very large profit to the contractor. Certainly the expenditure of such a sum should have secured a much more permanent and reliable structure.

Timber for trestle work was obtainable on the adjacent hills. Local sawmills furnished lumber at $25 per thousand; the distance to supply points was twenty-five miles, with roads fair and generally level, except five miles which had from 2 per cent to 10 per cent grades. The cost of hauling supplies was 75c. per cwt. The wages were, for foreman, $150 per month, and board; for shift bosses, $125 per month, and board;

and for labor, $2 to $3.50 per day. Board cost 75c. per day. Rubber boots and slickers were furnished to men working in water.

The accompanying table shows the cost of sluicing for each year. The year's program was, March 25 to 31, organizing forces and securing supplies; April 1 to May 1, digging channel in power canal, and cutting ice out with water; May 1 to 15, testing out plant, generally repairing power canal, building flumes, etc.; May 15 to Oct. 1 to 10, sluicing. Ice often froze and weighted down flumes prior to May 15 and after Sept. 15. By Oct. 10 it was impossible to work, and work was generally suspended, as the men were hard to hold on account of the freezing water in which they worked.

Diagram for Computing Paint Values

IN *Engineering News-Record* of Jan. 6, p. 42, Prof. A. H. Sabin discussed the question of how much a paint user can afford to pay for paint which will last, say four years and costs $6 per gallon to apply, when he has available at $3.50 per gallon another paint, which also costs $6 to apply, but which lasts five years. The chart reproduced herewith enables such cost calculations to be made more rapidly. It includes the three factors of paint cost, labor cost to apply the paint (both in dollars per gallon), and years of life. Three explanatory diagrams below the main diagram show the method of using it in three different calculations.

In the first example, the case calculated by Prof. Sabin is shown. One paint is worth $3.50 per gallon, costs $6 per gallon to apply, and will last five years; then how much is a gallon of paint worth that lasts only four years, the cost of application being the same? At the intersection of the horizontal for $3.50 paint cost with the vertical through $6 labor cost (upper scale), the diagonal (which represents cost of a gallon of paint applied) is followed down to where it meets the sloping line representing five years of life. From here, following back the horizontal to intersect the line for four years of life, the total-cost diagonal is followed down to intersect the labor-cost vertical, giving the horizontal line $1.60, which is the value per gallon of the second paint.

In the second small diagram the problem is worked out of determining how long a given paint must last in order to be as economical as another paint, for which cost and length of life are known. Following through the lines shown on the diagram, it will be found that a life of 3.47 years should be expected of the cheaper paint.

Sometimes computations of justifiable labor cost to apply paint may have to be made. The third of the small diagrams shows such a calculation.. A $3.50 paint is used whose spreading rate requires a man to spend $6 worth of labor time to apply it, and it is customary practice to repaint every five years. If instead a cheaper paint, bought for $1.60 per gallon is used, which, however, requires repainting every three years, it may not pay to spend as much labor in applying it. The calculation, carried out as indicated on the diagram, shows that not over $4.10 labor cost per gallon should be spent.

The formulas by which the calculations may be carried out are noted on the diagrams. Ordinarily, however, the diagrams themselves will be found much more rapid than numerical computation.

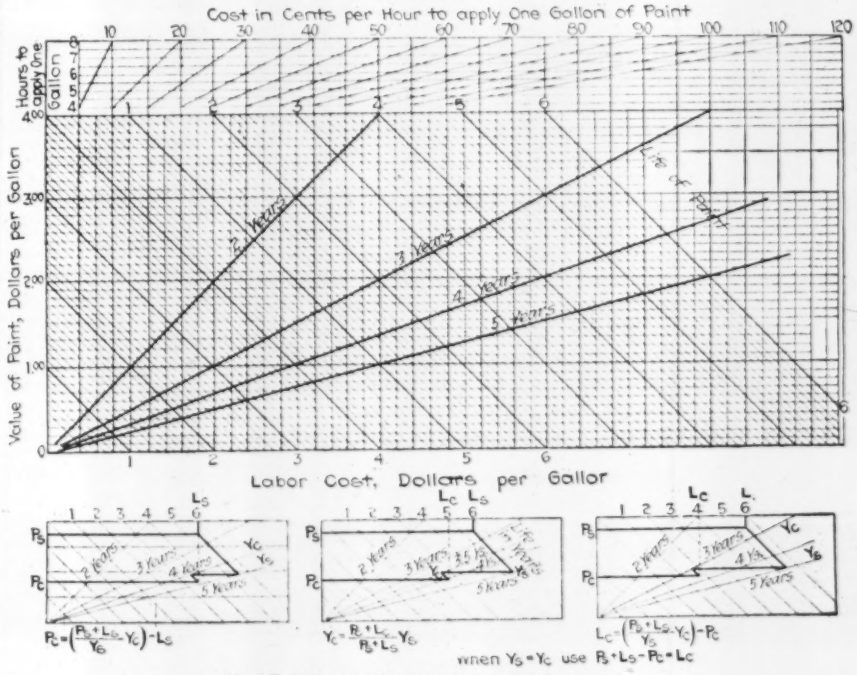

Cost in Cents per Hour to apply One Gallon of Paint
Hours to apply One Gallon
Value of Paint, Dollars per Gallon
Labor Cost, Dollars per Gallon
2 Years
3 Years
4 Years
5 Years
when Ys = Yc use Ps + Ls - Pc = Lc

CHART FOR DETERMINING PAINT VALUES

Study of Sulphur and Phosphorus

TEST of rivet bars and rivets madew ith various sulphur content including sulphur well above present allowable limits are in progress at the Watertown Arsenal and the Naval Experiment Station at Annapolis, according to information just issued by the joint committee on investigation of phosphorus and sulphur in steel (G. K. Burgess, chairman, C. L. Warwick, secretary). These tests will shortly be extended to plate and shape steel with carbon ranging from 0.06 to 0.22 per cent, manganese 0.35 to 0.40 per cent, phosphorus normal, and sulphur varying from 0.03 to 0.08 per cent. Still higher sulphur content will be subjected to test in material rolled from special ingots recently made with sulphur (iron sulphide) added after pouring, the maximum in this series being 0.15 per cent. This material will be tested transversely as well as longitudinally.

Studies are being initiated to devise service tests on material of high sulphur or high phosphorus content. The joint committee is also continuing its efforts to secure material that has either failed or proved itself in service, with sulphur or phosphorus content above normal.

Tests Fix Vehicle Tunnel Ventilation Policies

Carbon Monoxide Limit of 4 Parts Per 10,000 Established—Forty Air Changes Per Hour in Tubes

BASED upon the results of experiments conducted jointly with the U. S. Bureau of Mines, the New York-New Jersey Tunnel Commissions have determined upon general policies of ventilating the two 29-ft. subaqueous tubes which involve fresh air requirements of 3,600,000 cu.ft. per minute, equivalent to about forty changes of air per hour in each tube. The tests also show that safe conditions will result if a dilution of the exhaust gases of motor vehicles using the tunnel is regulated so as to limit the amount of carbon monoxide to 4 parts per 10,000. The results of the tests are summarized in the 1920 annual report of C. M. Holland, chief engineer of the commissions, the source of the following notes:

The ventilation of the tunnels, about 8,300 ft. long between portals, has been investigated under the following three subdivisions: (1) Amount and composition of exhaust gases from motor vehicles; (2) the dilution necessary to render the exhaust gases harmless; (3) method and equipment necessary for adequate ventilation.

Impurities in the atmosphere of a tunnel used by motor vehicles are the products of combustion of gasoline. Ventilation requirements are largely dependent upon the amount of carbon monoxide produced. This gas is a result of incomplete combustion and is poisonous. It has an affinity for the blood and reduces its oxygen-carrying capacity. The symptoms of carbon monoxide poisoning are headache, nausea, weakness of the limbs, and, in severe cases, unconsciousness.

Amount and Composition of Exhaust Gases—Tests under the direction of A. C. Fieldner, supervising chemist, were made on 101 motor vehicles to determine the amount and composition of exhaust gases. The motor vehicles tested were classified in four groups—passenger cars, trucks under 2-ton capacity, 2 to 5 tons, and 5 tons and over. The average results of all road tests show that at a speed of 6 miles per hour the exhaust gases of trucks contained the following percentages of carbon monoxide: 7.44 on up-grade, 5.38 on down-grade, and 7.56 on level-grade, with corresponding quantities of carbon monoxide, in cubic feet per car per minute, of 1.95, 0.72 and 1.40. At a speed of ten miles per hour, the corresponding percentages for trucks were 6.20, 6.22 and 7.30, and for passenger cars, 7.03, 6.30 and 7.19, with corresponding quantities of carbon monoxide in cubic feet per car per minute for trucks of 2.43, 1.21 and 1.99, and for passenger cars, 1.33, 0.62 and 0.99. The average percentages of carbon monoxide in the exhaust gases for all cars tested were: With engines idling, 6.72; engines racing, 7.37; accelerating from rest up maximum grade, 6.40; with corresponding quantities of carbon monoxide in cubic feet per car per minute, 0.644, 1.53 and 2.11. The fact that the quantity of carbon monoxide produced per minute with engine idling is small shows that where traffic is blocked and the cars crowded closer together than during normal operation, the ventilation requirements would be no greater than during normal operation.

The experiments also included the determination of the heat produced by the combustion of gasoline and it was found that 1 lb. of gasoline produced 14,910 B.t.u. In general, the results of the test showed that the exhaust gases contained about 6.8 per cent carbon monoxide and 8.4 per cent carbon dioxide, developing only 67 per cent of the heat value of the gasoline, so that about one-third of the gasoline fuel used for motor vehicles is wasted through incomplete combustion.

Dilution of Gases—Experiments to determine the proper dilution to render the exhaust gases harmless were conducted at the Bureau of Mines Experiment Station at Yale University under the direction of Dr. Yandell Henderson, consulting physiologist. Members of the staff spent periods of 1 hr. in a chamber of 226 cu.ft. capacity in amounts of carbon monoxide varying from 2 to 10 parts per 10,000. In addition, tests were also performed on a large number of persons in a chamber of 12,000 cu.ft. capacity into which an automobile engine exhausted. The length of time required to travel through the Hudson vehicular tunnel from portal to portal at a speed of 3 miles per hour will be 31.4 min. and the 1-hr. test, therefore, was considered sufficient. The average speed of passenger cars through the tunnel will probably be not less 10 miles an hour, requiring a 9.4-min. trip. It is considered, the report states, that a standard adopted on a basis of 45 min. time in the tunnel will assure the safety of passengers.

The physiological effects of carbon monoxide are wholly due to the union of carbon monoxide with the hemoglobin of the blood. The combination of carbon monoxide and hemoglobin is a reversible action, so that when a person returns to fresh air the carbon monoxide is gradually eliminated. Headache proved the most definite and reliable sign of carbon monoxide poisoning. Concentrations of gas too weak or periods of exposure too short to induce this sign are considered harmless. No one had this symptom to an appreciable degree after a period of 1 hr. in the chamber with 4 parts per 10,000 of carbon monoxide. With 6 parts the degree of effect, if any, was usually very slight, while with 8 parts there was decided discomfort for some hours, although not enough to interfere with the continuance of efficient work in the laboratory or at the desk. The accompanying table summarizes the experimental results for 1-hr. exposure to various concentrations in the chamber:

Parts CO in 10,000 Parts of Air Breathed	Corresponding Equilibrium Value for Blood Percentage Saturation	Percentage Saturation in Blood After 1 Hr.	Headache
2	23	11–12	None
4	36	16–20	None
6	47	18–26	None or slight
8	53	32–34	Distinct
10	58	38	Marked for several hours

Passengers in cars going through the tunnel in about 10 or 15 min. will absorb very little gas. The standard recommended for the tunnels—a uniform concentration not exceeding 4 parts carbon monoxide in 10,000 parts of air or its equivalent is considered a safe and conservative figure. Risk of considerable discomfort would begin at from 8 to 9 parts. These conclusions agree closely with others arrived at independently by Dr. Haldane, the British authority.

Ventilation Method and Equipment—The estimated capacity of the 20-ft. tunnel roadway with two lines of

motor vehicles operating in the same direction is 1,900 vehicles per hour. In calculating the ventilation requirements, however, this number has been increased as a basis for determining the amount of fresh air required. Assumed speeds and spacing in the two lines of traffic have been used giving a total of 2,113 vehicles per hour, or about 11 per cent greater than the estimated capacity of the tunnel.

ESTIMATE OF TRAFFIC FOR VENTILATION EQUIREMENTS

	Vehicles per Hr	Per Cent of Total Traffic	Vehicles in Tunnel
Fast Line (speed 10 mi. per hr., spacing, 40 ft.)			
Pleasure cars	360	17	57
Trucks less than 2-ton capacity	180	8 5	28
Trucks, 2 to 5 tons	780	37	123
Slow Line (speed, 6 mi. per hr., spacing 40 ft.)			
Motor trucks 5 tons and over	793	37 5	208
Total	2,113	100 0	416

The road tests on motor vehicles showed that the volume of carbon monoxide produced varies with the gradients. For the conditions of traffic as given in the table, 293 cu.ft. of fresh air per minute per foot of up-grade are required, 124.6 cu.ft. for the down-grade and 224.5 cu.ft. for the level-grade. The sections from the tunnel portals to the street surface will be either entirely open or sufficiently open to allow of natural ventilation. The following tabulation shows the amount of fresh air in cubic feet per minute required on the various grades in each tube:

CUBIC FEET OF AIR PER MINUTE FOR VENTILATION

	Up-Grade	Level-Grade	Down-Grade	Total
North tube	810,145	757,687	266 074	1,833 906
South tube	701,735	757,687	323,277	1,782,699
				3,616,605

This represents 54, 42 and 23 air changes per hour on the up-grades, level-grades and down-grades, respectively, or an average of 41 changes per hour for the north tube and 40 changes per hour for the south tube.

In considering the method of ventilation two general methods have been studied, namely, longitudinal and distributive. High air velocities and lack of definite control have led the commissions' engineering staff to discard the longitudinal method of ventilation and to recommend a distributive method whereby air is introduced into and exhausted from the tunnel through a number of openings at frequent intervals leading from the roadway. The fresh-air duct is to be located below and the exhaust duct above the tunnel roadway. Fresh air, supplied by blower fans at the shafts, will be discharged from the main ducts through adjustable openings into continuous expansion chambers on each side of the roadway, from which the air will escape into the tunnel. The exhaust ducts, located above the roadway and connected with the exhaust fans at the shafts, will have openings of varying sizes provided with adjustable shutters. By making the openings for the intakes and outlets adjustable, it will be possible to regulate the volume of air supplied and withdrawn so as to meet the requirements of traffic.

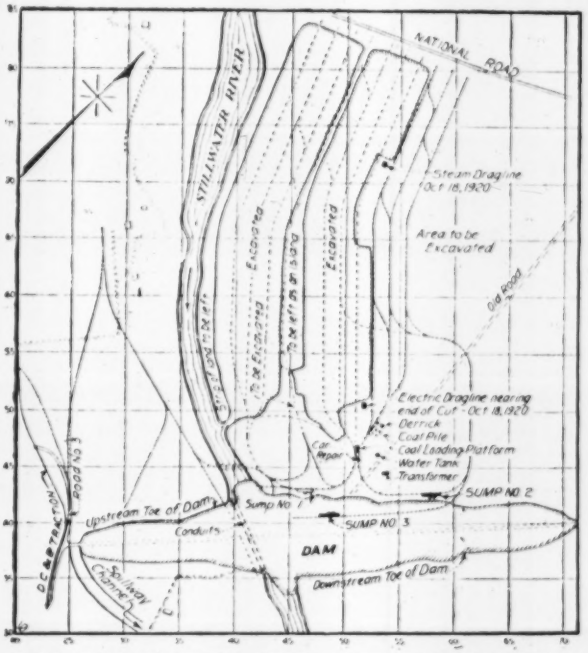
Each tunnel will have four ventilating shafts, two located near the pierhead line and the others about midway between these points and the portals. The distance between river ventilating shafts is about 3,375 ft. In co-operation with the U. S. Bureau of Mines a series of tests is now being conducted at the University of Illinois to supply data for an adequate and economical design of the ventilating ducts for the tunnels.

Dragline Excavator Operations at the Englewood Dam

By H. S. R. McCurdy
Division Engineer, Englewood Dam, Miami Conservancy District, Dayton, Ohio

CONTINUOUS high output, because of the plan of operation followed, has been recorded by the dragline excavators at work on the Englewood dam of the Miami valley flood protection works. These machines are loading a coarse glacial gravel into 12-yd. cars hauled in five-car trains to hog-box sumps, whence the dumped material is pumped into the dam embankment. Working two 10-hour shifts the monthly output for each excavator has averaged 75,000 cu.yd. To date the best performance of a single machine has been to load 274 cars or 2,740 cu.yd. in a 10-hour shift. At three bucketfuls to a car this performance involves 82.2 scoops and swings per hour.

As shown by the map, the borrow pit area at Englewood is about 2,000 ft. square. The depth of excavation



BORROW PIT AND SPOIL TRACK LAYOUT AT ENGLEWOOD DAM

is from 15 to 20 ft. When the dam is completed the pit connecting with the Stillwater River will form an artificial lake of about 200 acres.

Two 115-ton draglines, one steam and one electric, fitted with 85-ft. booms and equipped with 4½-cu.yd. buckets excavate and load the material. The loading tracks run north and south across the pit area, at intervals of 150 ft., with connections to each other and to the sumps as indicated by the map. All cuts run north and south and are made progressively across the pit from west to east. The draglines travel up one cut and down the next, being spaced about 1,500 ft. apart along the cut. By this arrangement one machine reaches the middle of the pit as the other reaches the end and both move to the new cut at about the same time. In each cut the machines excavate the area between the face of the previous cut and the loading track, backing along as they work, as the map indicates.

There are six materials trains. The empty trains run from the sumps directly to the southerly dragline, waiting there for the trains to be loaded and moved ahead. A train stands at each dragline. As the northerly machine is loading the next to the last car the engine runner blows his whistle. At this signal the train, also partially loaded, at the southerly dragline proceeds to the northerly dragline and an empty train takes its place at the southerly dragline. Time for the shift is provided by the period required to load the last car of the northerly train. Should it happen that a train at the southerly dragline is fully loaded before a signal comes from the northerly dragline it moves directly to the pumps by means of a cross-over from the loading track. This schedule is sufficiently flexible to meet actual operating conditions and reduce the dragline delays due to train service to very limited periods. It is worth note perhaps that experience with over two million cubic yards of excavation shows that each 4½-cu.yd. bucketful excavated builds 3 cu.yd. of dam embankment.

The Englewood dam is a portion of the flood protection works of the Miami Conservancy District, Arthur E. Morgan, chief engineer, Charles H. Paul, assistant chief engineer and C. H. Locher, construction manager.

Milwaukee Chemists Say Postpone Water Filtration

AN ADVERSE report on the proposed water filtration plant for Milwaukee has been made by a committee of the local section of the American Chemical Society and endorsed by the section, according to the March *Chemical Bulletin*. This report is the result of a request made by the Mayor to the local section for an opinion on the recommendations of J. W. Ellms in his report on the Milwaukee water purification experiments and plans for treating the supply (*Engineering News-Record*, Aug. 5, 1920, p. 297). The principal finding of the committee (George N. Prentiss, chairman) was that water filtration will not remove tastes and odors in the Milwaukee water which are due to products from the chlorine treatment of water contaminated by phenol derivatives in industrial wastes, whereas the activated-sludge process will keep the phenol derivatives out of the lake or else so change them that they will not combine with chlorine to cause tastes and odors in the water.

Other points made are (1) that chlorination will continue to insure a safe water until the sewage treatment plant is in operation when the contamination will decrease with a corresponding decrease in chlorine required; (2) that contamination from passing vessels can be eliminated by federal regulation; (3) that most of the street contamination will be carried into the sewers by the first rush of storm water; (4) that the activated-sludge process will remove 90 per cent of the bacteria and 95 per cent of the solid matter in the sewage; (5) that some form of filtration is desirable but it can be deferred until additional chemical and experimental work has been done upon the problem of precipitation, filtration and chlorination, or even until the sewage treatment plant has demonstrated what influence it will have on these problems; (6) that recent experiments on sewage sedimentation and filtration on Jones Island justify consideration of their applicability to water filtration; (7) that an additional water chlorination house and equipment be installed for emergency use; (8) that the city endow one of the larger universities with a suitable sum for research on sewage and water along the lines of sedimentation, filtration and chlorination, the work to be carried on by an expert in modern physical and colloidal chemistry; (9) that a committee of chemists and engineers be appointed to act as an advisory and consulting body on all matters pertaining to water purification; (10) that all research and experimental work and all projects dealing with water purification and sewage treatment be under the jurisdiction of one body.

The committee points to the typhoid statistics of Milwaukee as proof that the water supply is not a present menace to health. It states that in 1919 the Milwaukee typhoid death rate was 3.5 per 100,000, placing it second best among cities of over 200,000 population, and says that advance figures for 1920 show a still lower death rate from typhoid.

The New Indiana License Law

POINTS in the Indiana license law, recently enacted, are as follows: It covers professional engineers and surveyors whose duties are not defined. They must obtain a license within six months after the act goes into effect. A State board of registration consisting of six members, at least two of whom shall be professional engineers and two land surveyors, is to be appointed by the Governor. Board members receive $10 per day plus expenses during the period of attendance at sessions. Registration costs $25 and annual renewal $10. "Evidence satisfactory to the board" is required. A reciprocity clause is included for those holding licenses from other states and provinces of Canada, where requirements are of a "standard satisfactory to the board."

Persons eligible must be more than 25 years old; citizens of United States or Canada; must speak or write English; be of good reputation and have been engaged for six years in active practice. Ten years' practice or graduation and four years' practice shall be regarded as *prima facie* satisfactory evidence of the applicant's qualifications. When evidence is not conclusive an examination may be given. Those now practicing may be registered at any time within a year. Revocation of license may be made in the case of gross negligence, incompetence or misconduct. Practicing or offering to practice, except for non-residents, is a misdemeanor punishable by a fine of from $100 to $500, or three months' imprisonment or both. Outside engineers may offer to practice and practice after filing application. Exemptions include employees of registered engineers and surveyors, officers of the United States when practicing as such, duly elected and qualified county surveyors. Corporations or partnerships may practice if the members are registered.

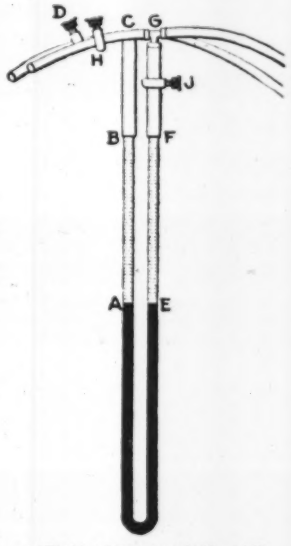
Traffic Chart Correction

Figures for the distribution of tonnage on the traffic chart on p. 339 of the Feb. 24 issue were erroneously given. The chart shows a total of 8,607 tons, which should have been distributed as follows: Pleasure motors, 6,556 tons or 76.1 per cent of the total tonnage; motor trucks, 1,807 tons or 21 per cent; motor-cycles, 17 tons or 0.2 per cent; horse-drawn vehicles, 227 tons or 2.7 per cent.

Excluding Air From Pitometer Piping

By F. W. Medough
Department of Engineering, Johns Hopkins University, Baltimore, Md.

THE usual method of expelling air from the pitometer piping preparatory to taking readings consists of the following steps: Close valve *J* (see figure) to prevent circulation and consequent loss of the carbon tetrachloride mixture. Open valves *D* and *H* and allow water to flow through freely until all of the air in the tubing between the water pipe and the valves has been expelled. Then close valves *D* and *H* and open valve *J*, thus allowing the liquid to circulate. Now very carefully open valves *D* and *H* a trifle at a time, so regulating the pressure that the liquid is forced up first in one side of the tube and then in the other. The result is that the water column *EF* is forced up to the position *FG* and any air bubbles between *F* and *H* are carried up and out with the outflowing stream. The same thing happens to air bubbles between *B* and *C* when the liquid is forced up in the other side.



PITOMETER PIPING AND VALVES

The only objection to this method is that is requires a very steady hand and the amateur usually allows the pressure to become too great on one side, with the result that the carbon tetrachloride mixture is shot past the bottom of the U-tube and lost. This may be easily avoided by running a fine wire through each valve so that one wire will extend from *D* to *B* and the other wire from *H* to *F*. Also between *B* and *C* add another valve, *K*, similar to the valve *J*. Now close valve *K* and open valves *H* and *J*, holding the discharge end of the tubing up a little higher than the tee. The air bubbles between *F* and *G* will travel up the wire and escape at the same time that the air is being pushed out of the tubing between the water pipe and the valve *H*. When all of the air has been expelled from one side close the valves *H* and *J* and open the valves *K* and *D* and allow the water to run until all of the air has been expelled from this side. Now close valve *D* and open valve *J* and the operator may begin to take readings. As the valves can be closed with the wire in the rubber tubing it is not necessary to remove the wire.

City Faces Damage Suits After Typhoid Epidemic

As a result of a typhoid outbreak in Pittsburg, Cal., ascribed to a polluted water supply, reference to which appears in *Engineering News-Record*, Dec. 30, 1920, p. 1288, and on p. 605 of this issue, 21 suits have been filed against the city by persons who were sick during the outbreak. The damage claims are reported to total about $140,000.

Letters to the Editor

If you have ideas that would interest engineers and contractors we shall be glad to give them space here. We urge, however, that you be brief so that a wide range of subjects may be covered in the available space.—The Editor.

The First Engineering School in America

Sir—In *Engineering News-Record*, Feb. 24, 1921, p. 349 there appeared a letter claiming that Norwich University and not Union College was the first college in America to give an engineering course. Neither of these was the first; the honor belongs to the Rensselaer Polytechnic Institute, Troy, N. Y. This school was founded by Stephen Van Rensselaer in 1824 as a school for "Instruction in Mathematics, Physics, Chemistry, Geology, and Natural History, with their application to Civil Engineering, the Arts, Manufacture, and Agriculture" and was at that time called the Rensselaer School. Professor Eaton, the senior professor, was a land surveyor in 1790 and in the catalogue of 1828 Eaton is put down as Professor of Civil Engineering. In a pamphlet of 1826 it says that surveying, hydraulics and mechanical powers were taught, as was likewise what was known of galvanic batteries and electrometers.

A full description of the college may be obtained from History of the Institute, John Wiley, 2nd ed., or may be found in "The New International Encyclopedia."

Danbury, Conn., March 28. Thomas M. Belden, R. P. I., Class of 1915.

Chlorination at Pittsburg, Cal.: A Correction

Sir—I wish to correct an erroneous impression given in *Engineering News-Record*, Dec. 30, 1920, p. 1288, under the title "Results of Stopping Chlorination One Day." I fear that a casual reader of this article, which is supposed to be an abstract of a paper recently prepared by me, would conclude that the typhoid outbreak at Pittsburg, Cal., resulted from a method of water-works operation consented to by the State Board of Health.

The article states that "as the population served is only about 5,000, a single small-capacity chlorination plant was considered sufficient." This department certainly did not so view the situation; nor did the city. As a matter of fact, an emergency hypochlorite installation and rapid sand filters were also provided at this plant.

The article further states that "for the short time during which chlorination was to be discontinued it was not considered necessary to start up the chlorine of lime plant." It should be added that the person who took it upon himself to decide this point was the plant operator. Neither the city officials nor the State Board of Health were notified of a cessation in treatment. When the typhoid outbreak brought on an investigation revealing the facts, this operator and the superintendent of water-works were both discharged.

The article then states that "In view of this experience Mr. Hilscher recommended the installation of duplicate chlorination plants." Such a recommendation was not made in the case of Pittsburg. The epidemic was due to careless operation and not a lack of equipment. Furthermore, the city at that time had nearly completed development of a well supply and within a month following the epidemic the river supply was permanently abandoned.

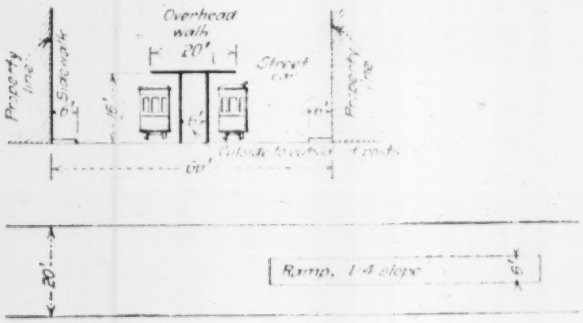
Very truly yours,

Berkeley, Cal., Jan. 4. Ralph Hilscher,
Director Bureau of Sanitary Engineering
California State Board of Health.

[We regret our misunderstanding or misinterpretation of the paper in question.—Editor.]

Elevated Sidewalk Proposed to Relieve Traffic Congestion

Sir—Nearly all cities face the congested traffic problem. It is also well known that the 66-ft. street is a factor to be reckoned with. The accompanying sketch shows construction of a proposed 20-ft. sidewalk directly over the street car lines. The supporting columns are 6 ft. from outside to outside. This gives a 6-ft. platform in the center of the street which will facilitate loading and unloading street



cars. The ramps are 6 ft. wide and have an easy 1:4 slope. Retail merchants would favor the construction of this central sidewalk as it would equalize both sides of the street. Practically all stores would make a connection with the sidewalk. The construction of the central overhead walk would mean cutting down side walk property line to 6 ft.

Olympia, Wash., March 20. FRANK W. HARRIS.

In Defense of the Marshall Plan

Sir—In your issue of Feb. 10, 1921, p. 273 there was published a letter under the caption "Marshall Plan For All-California Irrigation Held Chimerical" in which the Marshall plan was roundly scored as being "chimerical," "ill conceived," "fantastical," etc. In the same issue was a notice that the San Francisco section of the American Society of Civil Engineers has passed resolutions condemning the Marshall plan.

Now, what is the Marshall plan, and why the haste to condemn it, out of hand, as it were? Briefly, the Marshall plan proposes to impound in storage reservoirs along the upper sources of the rivers, the flood waters of the rainy season, and to distribute them during the dry season; to divert a portion from the northern part of the state where there is an excess, to the southern portion where there is a deficiency. In the completion of this plan at least five great objects are to be accomplished: (1), Complete control of the spring floods with elimination of the heavy annual cost of levee work; (2), a state control of all available water resources with equitable distribution; (3), irrigation of a vast domain of potentially rich valley lands; (4), generation of hydro-electric power; (5), adequate supplies of potable water to all communities.

These problems have been pressing for solution with ever increasing urge and the past year, which was the culmination of a series of very dry years in California, has served to forcibly bring them before the public mind as never before. By reason of the small fresh water flow in the Sacramento River last summer the salt water from the ocean crept many miles inland carrying with it the teredo, which destroyed many thousands of dollars worth of wooden piling hitherto immune, and polluted the drinking water of some of the cities along the way. In consequence, one of these cities started litigation against the irrigationists along the upper stretches of the river and while the present heavy rainfall will relieve the situation for the time being, it is evidently no guarantee against future recurrences of a similar nature.

Water rights in California have been the source of long and expensive litigation and the end is not in sight. Private owners, the state of California and the Federal Government have spent hundreds of thousands of dollars in dredging, straightening and levee work along the Sacramento and San Joaquin rivers and are still at it. Irrigation projects in the past have been developed or promoted with little or no regard for the interests of anyone outside the particular territory involved and similar schemes are constantly being agitated. San Francisco has turned to the Sierra Nevada mountains for a domestic water-supply and the cities on the east side of San Francisco Bay, already warned by their local water company that its limit of development will provide for only ten years more of normal city growth are trying to get together upon some method that will insure a supply adequate for their future needs.

Surely, no time is more opportune than the present for a broad gage and impartial solution of these troublesome matters if any such can be had. This, it is believed, the Marshall plan, if feasible, will accomplish, and the California State Irrigation Association is asking the state legislature to make, through the state engineering department, a thorough investigation of the project.

Col. R. B. Marshall who has proposed this comprehensive scheme was for many years in charge of the United States Geological Survey's topographic work in California and is therefore acquainted, as is probably no other man, with the state's topography as a whole. After a lifetime of labor in this particular field he is staking his reputation on the assertion that the plan he has developed is physically practical and the question is too important for the state of California to refuse it serious consideration.

Alameda, Cal., Mar. 17. G. B. ASHCROFT. Civil and Structural Engineer.

Wind Pressures on Surfaces

Sir—In *Engineering News-Record*, Feb. 24, 1921, page 352, is a discussion of the effect of wind pressure on inclined surfaces. Both parties seem to put their faith in formulas which were developed before the advent of the airplane had given its great impetus to the study of aërodynamics. It would seem to an engineer in touch with aëronautical work that the proper way to learn the effect of wind on buildings is the method used to determine its effect on an airplane wing; i.e., by wind tunnel tests on a model. Instead of relying on the old formulas of Hutton and Duchemin for their wind loads, civil engineers should obtain the co-operation of aëronautical engineers to obtain wind tunnel tests that would determine the wind loads which should be assumed for different conditions.

In view of the number of wind tunnels in existence, as at the Bureau of Standards and the Massachusetts Institute of Technology, to name only two, there is little excuse for engineers using formulas for wind pressure handed down from the "dark ages" of aërodynamics instead of using our modern facilities for obtaining correct data.

ALFRED S. NILES,
Aëronautical Structural Engineer,
Engineering Division, Army Air Service.

Dayton, Ohio, Mar. 7.

British Road Classification Is Nearing Completion

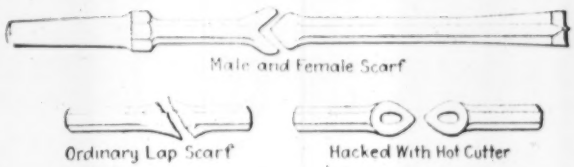
The classification of roads under the British Ministry of Transports' scheme is nearing completion and, when the schedules reach their final form it is the intention of the ministry to distinguish each first- and second-class road by an individual number. Another feature of the scheme is the standardization of warning signs and road direction posts; provision has been made for indicating the route numbers on the arms of posts in the belief that "the universal adoption of this practice would be of the greatest service to road users generally." These details are included in a letter from the ministry to the highway authorities in England. The letter concludes by saying that Sir Eric Geddes is not advocating "any wholesale replacement of serviceable signs at the present time.

HINTS FOR THE CONTRACTOR

Reclaiming Hollow Drill Steel

BY J. C. LAMON
Calderwood, Tenn

IN QUARRY and mine operations where jackhamers and water-line drilling machines are used largely, many pieces of hollow drill steel become broken owing to the hard use to which they are put. Considerable loss is involved unless some proper method of reclaiming this steel is devised. Hollow drill steels should first be collected and classified, so that in reclaiming the original lengths can be kept.



METHODS OF SCARFING STEEL FOR THE WELD

It is essential to pay proper attention to the arrangement of the forge fires and the use of high-grade smithing coal. Slaked coal having no lump larger than that which will pass through ½-in. mesh should be used.

In building the forge fire dampen the coal and thoroughly mix it until it is in a plastic condition. Then place a block of wood 4 in. x 4 in. x 15 in. on the draft opening, and fill up around the block thoroughly and pack the coal with a sledge. Remove the block and fill up the hole with live coals, oily waste, or any dry material which will ignite readily. When the fire is well started, put on some coke, allowing the fire to get hot before welding operations proceed. The idea in this is to confine the fire to a very small area so that the welding operations can proceed with ease.

The plane of the anvil should be that of the forge. On the side of the anvil opposite the forge place some sort of rigid frame upon which the drill steel can rest and against which they may be thrust when the welding operations begin. If the male-and-female-scarf method is used, the pieces of scarf steel are driven together in the fire, then withdrawn on the anvil. Careful attention to the scarfing details should be made regardless of the methods used.

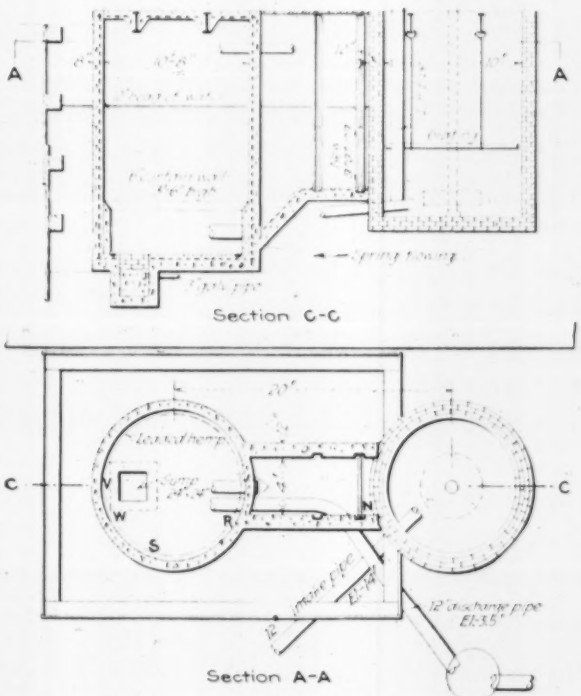
In diagonal scarf welding the broken ends should be heated to a forging heat a distance of approximately 3 in. from the break and where the weld is to be. After heating, drift holes with a long tapered drift pin. Then with a sharp hot cutter cut the steel diagonally to form the scarf. Drift out the hole again and pack the scarf with the hot cutter. Place the steel in the fire, scarf side up. Take a slow heat, applying a little welding compound. When at the proper welding temperature, bring out the steel and make the weld on the anvil. After the weld has been made, the holes can be cleared out of all scales with a small wire. Place the steel in a dry place and allow it to cool. Care must be exercised in both heating and cooling as only in that manner can forging strains be removed and the drill steel be insured against breaking at or near the weld.

Waterproofing a Vertical Lift Well

BY GEORGE L. KNOTT
Civil Engineer, Brooklyn, N. Y.

WHILE the writer was superintendent of public works at the Naval Operating Base, Hampton Roads, Va., he had charge of a new concrete lift sewer well 10 ft. 8 in. in diameter, 17 ft. deep, with 8-in. walls, and with ⅜-in. rods for reinforcing the sides and ½-in. rods for bottom slabs. The passageway between the wells was 12 in. thick, with reinforcement only at the bottom. The concrete mixture was 1 : 1½ : 3, with 5 lb. of hydrated lime for integral waterproofing. The earth pressure assumed was 90 lb. per cu.ft.

The material excavated was a heavy muck, and 6 ft. below the surface water was found. A running spring with a 10-ft. head of water was also encountered. The muck weighed 130 lb. per cu.ft.



SECTIONS OF SEWER LIFT WELL SHOWING LEAKAGE POINTS

When the excavation was completed and the water was pumped out the inner and outer forms were placed, the pumps working all the time. The labor foreman was instructed to complete the job in one day without the top slab in place and to puddle well the sides of the shell in placing each batch of concrete. After pouring the concrete the spring broke through the sump and we had to allow the water to remain for seven days before stripping the forms. We then pumped the water out, finding additional leaks at *N* and *W*. We then decided to build an inner curtain wall 3 ft. 6 in. high, 6 in. wide, of a 1 : 1½ : 3 mixture with 5 lb. of hydrated lime per batch of concrete. After this had set three days we

stripped off the forms and again pumped the water out. Only the leak at W had stopped.

As the leak in the sump was a bad one, we inserted a 3-in. galvanized pipe under the slab and forced the water to come to one place. We then capped the pipe and soon had other leaks as the water arose outside. We uncapped the pipe, brought pumps to both inside and outside, and then had the outside back-filled with well-tamped heavy muck in the hope of forcing the stream off from the bottom slab. When the backfilling was completed we capped the pipe again, filled the sump up with concrete, incasing the pipe in it, but still the water leaked through.

We then chipped up the 1-in. concrete inner surfacing, drove down at the edge of the inner curtain wall leaded hemp 1 in. deep, then applied 1 in. of new finish over all. We then took common brick, heated it and placed it in the sump, flush with the inner bottom. We troweled the cement hard, and found after cooling we had no more leaks from the sump.

Concrete Truss Spans Erected Without Falsework

IN ERECTING the six 66-ft. truss spans of a reinforced-concrete highway bridge at Wichita Falls, Tex., the contractor used a scheme of construction that eliminated the necessity for falsework. This resulted in a cost very much lower than bids submitted for concrete arches and made it possible to carry on the work without regard to the stage of the river or fear of settlement in the falsework supports. In place of the usual falsework a pair of steel trusses, supported by the piers for the permanent structure, carried the weight of the concrete during erection. These steel trusses were moved along from one span to another as the work progressed. The concrete trusses were cast in a horizontal position on a temporary floor carried by the steel trusses, and after hardening were raised to their final vertical position by tackle slung from the top of the steel trusses.

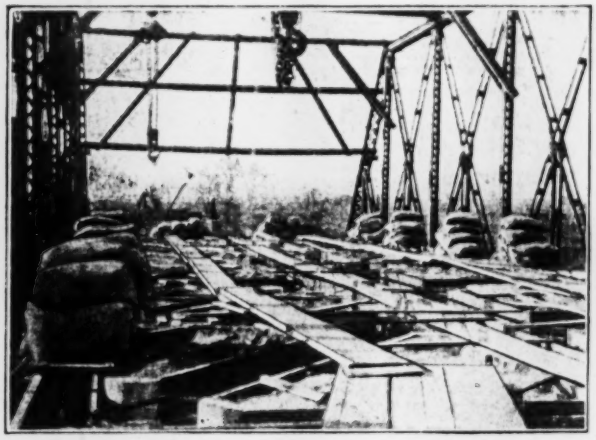
This method simplified the pouring of concrete, as the forms used consisted chiefly of simple triangular frames or bottomless boxes placed on the temporary floor. The depth of these forms was the width of the truss. The forms were so placed that when the truss was raised to a vertical plane it was very nearly in its final position, so that a minimum of handling was necessary.

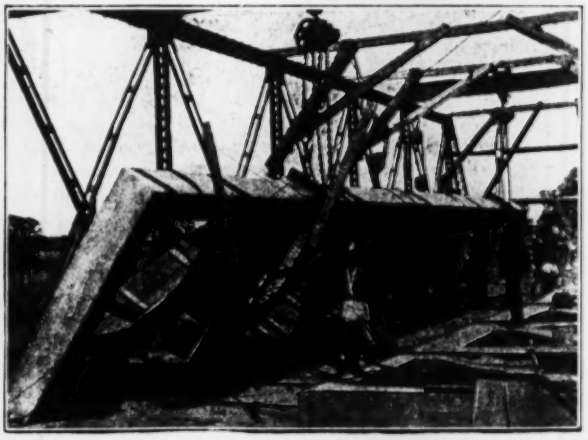
In order to avoid getting lateral curvature in the concrete trusses due to deflection of the steel trusses under the weight of the concrete, the temporary bridge was so cambered that the weight of the concrete would bring the floor to a horizontal line. The sand and gravel to be used in the concrete was sacked and, together with the cement, also in sacks, was distributed uniformly along the span before any of the concrete was mixed and poured. Thus the full deflection in the steel trusses occurred before the pouring commenced, and did not change afterward.

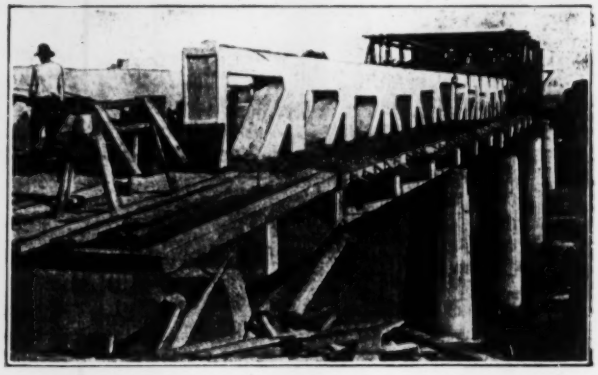
Provision for supporting the floor beams was made at the time of casting the trusses, rectangular openings being left in them for this purpose. The floor beams are 42 in. deep and 15 in. wide; their reinforcement continues on through the openings and serves to reinforce the cantilever brackets supporting the 4-ft. sidewalks built on the outside of each concrete truss.

When the work on one span was finished, the steel trusses were moved forward to the next span, first on rollers resting on the top chords of the concrete trusses and later, after the trusses were half way across the new span, on another set of rollers underneath the bottom chord of the concrete trusses, the steel span acting as a cantilever during the process.

The contractor, the Jenkins Bridge and Construction Co., of Denver, Colorado, reports that the same method was used to good advantage on the erection of several other bridges.







BUILDING CONCRETE TRUSS BRIDGE AT WICHITA FALLS WITHOUT USING FALSEWORK

Forms in Place on Floor of Temporary Bridge—Raising Finished Truss—Floor Concreting

NEWS OF THE WEEK

New York, April 7, 1921

Sewage-Works Studies To Be Made at Akron, Ohio

A complete study of the sewage-works of Akron, Ohio, is to be made by Harrison P. Eddy, of Metcalf & Eddy, consulting engineers, Boston, to determine the proper loading of the plant, what minor additions and changes should be made and what repairs and reconstruction are required to place the plant on a more efficient basis. The Akron sewage-works were completed in 1916 at a cost of about $425,000 and up to recently were second largest sewage treatment plant in Ohio using Imhoff tanks with sprinkling filters. The plant was designed to take care of the sewage of Akron until 1930, but due to its rapid growth, the plant has been working under an overload almost since it was put in operation.

The site of the present sewage-works has been selected by the city authorities for park, playground and recreational purposes, so that eventually the plant will have to be located elsewhere, according to information received from J. E. Root, engineer, bureau of sewerage, Akron, Ohio. It is probable, Mr. Root states, that a new site will be selected at 5 or 6 miles north of Akron on the Big Cuyahoga River. It is also expected that complete investigation and plans for the new sewage-works will be prepared during the coming year. The present idea is to build at the new site sufficient units to treat the excess sewage for the next eight or ten years over the sewage that can be treated at the old works. Mr. Eddy will direct special attention to immediate changes to get the old plant on the best possible operating basis so as to give more efficient service for the balance of its period of use. The engineering departmnt of the City of Akron will work jointly with Mr. Eddy and his engineers on the sewage treatment question. A preliminary estimate for new treatment will exceed $2,000,000.

In 1920 about $900,000 worth of sewerage work was completed in Akron and it is expected that about $1,500,000 worth will be done this year. It is expected that an election will soon be held to vote on the authorization of an additional $5,000,000 to continue the Akron sewer construction program.

Pennsylvania May Tax Cement

It is announced from Harrisburg, Pa., that the legislative committee in search of new sources of revenue may tax cement production at its source. It is reported that a tax so placed would bring into the state about $2,000,000 a year. Already in the draft of the bill are taxes on minerals, lumber, oil, gas.

New York State Assembly of A. A. E. Organized

At a meeting held on March 12 at Albany, N. Y., the New York State Assembly of the American Association of Engineers was organized. Officers are S. J. Stone, general superintendent of the John Cowper Co., Buffalo, president; A. M. Knowles, assistant bridge engineer, Erie Railroad, New York, first vice-president; G. F. Scharbach, Lackawanna Railroad, Binghamton, second vice-president; J. G. Brennan, State Highway Department, Albany, secretary-treasurer.

Resolutions were passed protesting against the classification of professional engineers with mechanics and laborers on the part of railroads and other employing bodies. On the subject of the pending amendment to the New York State licensing law, the meeting expressed itself emphatically against the principle of licensing corporations to practice as professional engineers or land surveyors and requested the state legislature to support Bill 147, which would prohibit such practice.

The assembly was formed to co-ordinate the activities of all the chapters and clubs of the American Association of Engineers in the state on state issues, leaving full autonomy in local matters to the local organizations. It expects to co-operate with the state section of the Federated American Engineering Societies and other organizations. Two regular meetings are to be held in March and November respectively.

Modified Belle Isle Bridge Plans Approved and Advertised

(Special Correspondence)

Revised plans for the Belle Isle bridge over the Detroit River, prepared by Esselstyn, Murphy & Hanford, were presented to the Detroit city council on March 30 and were unanimously approved by that body. The commissioner of public works was authorized to advertise the work immediately (see advertising page 88 of this issue—EDITOR) and bids will probably be opened on April 23. This will be the third time bids have been called for, no contracts having been let on the two previous sets of bids because the lowest bid exceeded the amount of money appropriated.

In presenting his revised plans to the council, H. H. Esselstyn, whose firm is in charge of supervision of design and construction of the bridge for the city, stated that they can be carried out for less than $2,400,000, according to his latest estimate. This amount, with the cost of the approach subway under Jefferson Ave. already constructed will bring the total cost within the $3,000,000 voted by referendum four years ago. In revising the plans only minor changes were instituted, the commission's primary design for a concrete and steel cantilever bridge being adhered to mainly.

The approval of the council's latest action by Mayor Couzens is in line with the mayor's efforts at the second opening of bids to have bids accepted so as to get construction work on the foundation under way. It is the hope of the city officials that the bids will be within the desired limits and that construction work can be started in May.

Don Pedro Dam To Be Built by Day Labor

After twice receiving and rejecting bids for the construction of the Don Pedro dam on the Tuolumne River, California, to store water for the use of the Turlock and Modesto irrigation districts in the San Joaquin Valley, a joint board has decided to have the work done by day labor instead of by contract. On March 10 the joint board officially representing the two districts opened bids and voted to award the contract for the construction of the dam to W. A. Kraner of San Francisco. This action was rescinded March 17 before the contract had been actually signed. New bids were called for, to be opened March 22. At this opening six bids were presented—a less number than were received at the previous opening. On March 23, after a San Francisco banker had appeared before the board and offered to take the bonds of the district, all bids were rejected and the board announced the decision to do the work by day labor.

The dam is to be built on a simple curve with a radius of 675 ft. It will be 280 ft. high, 975 ft. long on the crest, and will contain 266,000 cu.yd. of concrete. Only about 10,000 cu.yd. of excavation are said to be necessary to expose solid rock underlying the site, but about 120,000 cu.yd. of excavation will be made in cutting a spillway channel in the canyon wall at the north end of the dam.

The construction program includes building a narrow gage railroad from the Southern Pacific line at Hickman to the dam site, a distance of 29 miles. About 12 miles from the dam site this railroad passes through gravel pits from which gravel for the concrete will have to be taken. It is estimated that the work can be completed in two years time at a total cost of approximately $4,000,000.

Council Committee Reports on Pittsburgh Slide

(Special Correspondence)

Following an extended investigation of the Jones Hollow landslide in Pittsburgh last November, the councilmanic committee that made the investigation has reported, laying the blame for the occurrence on the engineers in charge of the work. It states that insufficient precautions were taken in investigating the conditions at the site before starting work, and that authorization of departure from the contract provision that the hillside fill be deposited in layers and rolled was partly responsible for the accident. On the former point the report says:

> Regarding the matter of the sufficiency of the precaution taken in the investigation of conditions preliminary to starting work, however, we have no hesitation in expressing the opinion that such precautions as were taken were woefully inadequate, in view of the presence of the retaining wall at the bottom of the hill and the wooden cribbing erected some distance back of the wall.
>
> These two structures should have served as glaring danger signals, but apparently did not. There seems to be no possible excuse for the almost total lack of effort to secure available facts and data which the presence of the wall and the cribbing would seem to have demanded as essential, and without a knowledge of which it was extremely hazardous, to say the least, to proceed with the fill as planned. The problem which confronted the public works department in perfecting plans for the boulevard widening was essentially one of engineering, and the responsibility for the success or failure of the plan must rest upon the engineer who approved its adoption.
>
> Upon N. S. Sprague, therefore, as head of the city engineering department, must rest the responsibility, provided he approved of the plan as carried to execution. On this point, however, the evidence given in the hearing was flatly contradictory. Sprague himself testified that he had approved the plan; D. P. Williams, assistant counsel for the Pennsylvania R.R., testified that Sprague stated distinctly in his presence that "The engineering department of the city had not approved of the method adopted for improving the boulevard at that point . . . and that the engineering department will have to decline to assume any responsibility for the thing that happened.
>
> If Sprague's statement is true, then the responsibility for a huge engineering blunder is his own. If, on the other hand, Williams' statement reflects the truth, Sprague, impelled by a sense of loyalty to his superior officers, must have accepted deliberately a responsibility which did not properly belong to him. In this event it is obvious that someone higher in authority than Sprague must have over-ridden the objections of the engineering department and have insisted that the work be prosecuted regardless of the protests of the engineers.

Interviewed by the representative of *Engineering News-Record* on this report, Mr. Sprague said:

> The finding of the committee ignores all of the engineering testimony taken at the hearing and apparently is content and satisfied to fix the responsibility for the slide upon the basis of political expediency, rather than upon the engineering testimony submitted. The inconsistency of the report and the attitude taken by the committee is clearly shown by their willingness to place the responsibility for the slide upon the mayor and at the same time attempt to exonerate the director of public works on the grounds that he is not an engineer.
>
> The problem confronting the committee was essentially an engineering problem and if a finding was desired, based upon the merits of the case and the testimony submitted, the council should in all fairness have employed a board of disinterested engineers to review the testimony and make a report.

District Court Upholds Concrete Surface Roller Patent

In a decision rendered March 2, 1921, Judge S. H. Sibley, sitting in U. S. District Court for the Northern District of Georgia, declared valid claims 5 and 6 of U. S. Patent 1,273,022, "Process and Device for Finishing Concrete Pavements," which is a patent by W. A. Ashmore and W. T. Morgan, Jr., on the so-called "Macon roller" used in finishing concrete roads and pavements. The suit was brought by the Macon Concrete Roller Co. against the Brookes-Callaway Co., and alleged the infringement of the two claims in the use of the roller. This allegation was sustained in the decision. The judge held that the use of a light roller was new in the art and constituted invention. One of the claims sustained reads as follows:

"The herein described method of finishing concrete pavements and the like, which consists in rolling the surface of a freshly laid soft plastic concrete with a roller of small diameter and comparatively great length and light weight adapted to float on the soft plastic concrete and to act on the surface thereof as a straight edge, and subsequently rolling the same with a shorter and proportionately lighter floating roller to further smooth and finish such surface."

New Administrative Engineering Course at Union College

Union College, Schenectady, N. Y., has added a new course in administrative engineering designed for training managers and superintendents of industrial plants. The course covers a period of four years in which science comprises 26 per cent of the total time; engineering, 39 per cent; business administration, 10 per cent, and cultural studies, 25 per cent. The course includes studies in accounting, finance, banking, business law, contracts, and industrial management. It is designed for students more likely to be interested in manufacturing industries dependent upon engineering as a basis.

Chicago Receives Large Gifts for Bridge Tenders' Houses

Two gifts of $50,000 each have just been received by the city of Chicago for architectural development of the four bridge-tender houses on the new Michigan Ave. bascule bridge across the Chicago River. The gifts will be administered by the Chicago Plan Commission. C. H. Wacker, of the Commission, says that through the gifts "it will be possible to make the structure historically significant, a fitting capstone to Michigan Boulevard." The site of Fort Dearborn and the spot where stood the first white man's house constructed in Chicago are both included in the bridge plaza, he says, and both will be commemorated. The two gifts are from William Wrigley, Jr., owner of a building near the bridge, and the trustees of the Ferguson fund.

Road Opposes Commission's Order To Rebuild Bridges

Application for an injunction has been made by the Louisville & Nashville R.R. in the U. S. District Court at New Orleans to prevent the railroad commission of Louisiana from enforcing an order requiring the railroad to rebuild its gulf coast bridges over the Rigolets Pass and Chef Menteur. The petition alleges that there is no public necessity for the new bridges, that the expenditure of money required is grossly out of proportion to the benefits to be derived, that the receipts of the railroad during the last nine months of 1920 were more than $3,000,000 under operating expenses and that the cost of the two bridges would be $2,300,000 and $1,300,000 respectively, that the money could not be borrowed now except at prohibitive rates of interest, and that the Federal Reserve Bank and the Interstate Commerce Commission had both counseled against extension of credit at this time. No date has yet been fixed for a hearing on the commission's injunction.

Engineers Unemployed

Records of the employment service bureau of the American Association of Engineers show that approximately 10 per cent of the engineers in the country are out of employment. In many cases companies which ordinarily have 100 or more engineers on their staff now have only 8 or 10. The greatest demand for engineers is in municipal and highway work; there is little demand for railroad engineers and indications are that no improvement can be expected before August.

In February the following conditions existed:

	Feb. 1921	Feb. 1920
Applicants for employment	2,293	610
Positions received	552	504
Men referred	3,525	2,385
Men placed	286	172

The average monthly salary of positions filled during February was $195 and the total salary of all positions filled was $55,000.

First Engineers Decorated

The Secretary of War has accepted fourrageres from the French Government for several American regiments including the First Engineers. The citation referring to the First Engineers reads as follows: "A regiment which under all circumstances displayed ardor in combat, and the finest technical and moral qualities. During the counter-offensive to the south of Soissons it contributed to the success of the operations of the 1st American Division in attacking with the infantry on July 20, 21 and 22, and capturing all its objectives. In the course of the operations between the Argonne and the Meuse from September to November, 1918, it again showed itself worthy of its magnificent reputation."

Arkansas Road Financing May Lead to Inquiry

Local District Assessments Heavy—Federal-Aid Roads a Small Percentage of the Total

While conditions incident to the financing of road projects in Arkansas may lead to a Senatorial investigation of the Government's activities in the general field of highway construction under the Federal-aid act, as definitely promised by Senator King, of Utah, in an interview with *Engineering News-Record's* representative in Washington, April 4, it is pointed out by those familiar with the situation that the Arkansas muddle is a local one and is due essentially to the creation by the state legislature of local improvement districts with broad powers to issue bonds and levy taxes, over which the U. S. Bureau of Public Roads has no direct control. In fact, the Bureau, for some time past, has seen the trend of affairs in Arkansas and has endeavored, through suggestion by its own representatives, to have defects in the existing laws remedied. This effort, to date, has been fruitless.

Approval of many of the Arkansas Federal-aid projects has been refused by the Bureau and of a total allotment of $4,619,929 of Federal funds to that state about $800,000 had been paid up to April 1, 1921. Largely through the lavish and uncontrolled authorization of road bonds by the local districts there have been accumulated in the state, which has a population of 1,752,000 and an area of 52,525 sq.mi., outstanding obligations for road improvements of about $108,000,000. Heavy burdens on the taxpayers within comparatively small areas are thereby imposed. Federal-aid roads are a small percentage of the total—about 9,900 mi.—which the local districts have undertaken to construct.

Under the Arkansas law exclusive jurisdiction over roads and bridges is vested in local district authorities and much of the engineering work is done on a percentage basis—generally 5 per cent. In many cases, under the Alexander law, assessments for roads amounting to 30 per cent of the assessed property valuation of a district are permissible, in others the percentage under special acts of the Legislature rises to 50 and in one case to 90. Some of the districts overlap, thus imposing upon land-owners double taxes. Provision is made for a very low assessment ($2 per acre) on timberland, thereby giving the lumber interests road facilities for the transport of their products at a tax ridiculously small as compared with the general individual levy. Other irregularities are disclosed in the appointment, as paid district commissioners, of members of the state Legislature which creates the districts.

The history of how more than 100 Arkansas road projects have fared in the securir ; of Federal participation in their cost is as follows: Six projects proposed were informally inspected and cancelled as unsuitable; 18 projects were submitted, assigned Federal-aid numbers and then withdrawn on the ground of unsuitability; 10 projects were withdrawn and cancelled before plans had been made; 35 projects are now active in that location has been approved and plans prepared; 5 projects on which plans had been submitted were found to be incomplete and decision on them is pending; on 3 projects plans have been recommended for approval; in the case of 6 projects an actual agreement has been made between the Secretary of Agriculture and the State Highway Department; 1 project submitted and agreed to has been withdrawn by the State.

At the present time 44 projects are under contract. Of this number work is progressing on 33 and has been shut down on 6, due to lack of funds. On 3 projects conditions have been found unsatisfactory and Federal-aid funds have been withheld. One project is delayed by a suit against the district commissioners and another, under contract, in which the Federal-aid portion was only a small section of a longer road, has been cancelled. To date, 10 projects in Arkansas have been completed.

Among those who believe that little, if anything, will come of the proposed senatorial investigation of Federal road activities, it is pointed out that the Arkansas situation has no counterpart in the other states and is a matter of improper local legislation which only the state itself can correct.

Governor Miller Signs Bill for Port Treaty

Governor Miller of New York, April 4, signed the bill authorizing any two of the three New York members of the New York-New Jersey Port and Harbor Development Commission to sign a compact with commissioners from the State of New Jersey in the form of a Port Treaty, the terms of which are included in the bill and which provide for the creation of the New York Port Authority. The second port treaty bill, providing the means of appointment of members of the Port Authority, has passed neither branch of the New York legislature, at this writing, although it is ready for vote in each.

Governor Edwards of New Jersey vetoed both bills, April 5, the day after they reached him.

Last week both the first and second bills were passed by both branches of the New Jersey legislature. However, they did not formally go to Governor Edwards for approval or veto until April 4, allowing him until April 9 to act. It is expected that the legislature will promptly pass both bills over his veto, before the normal time of adjourning the session April 8. If such action has to be deferred, it is now planned by the Republican legislature to adjourn this week *sine die*, only to meet again next week to pass Republican measures over the veto of the Democratic Governor.

In the meantime the City of New York has taken legal steps to block the signing of the Port Treaty, obtaining an order to show cause why an injunction should not be ordered restraining the members of the New York-New Jersey Port and Harbor Development Commission and the Attorney General of the State of New York from entering into the treaty. Alleged constitutional grounds are cited.

Massachusetts Defers Action on Licensing Bill

By referring a petition urging the passage of a bill for the registration of professional engineers and land surveyors to its next annual session, the State Assembly of Massachusetts has disposed of the question of licensing in that state for the time being. A public hearing was given at the State House in Boston on Feb. 18 upon the bill submitted to the Massachusetts Legislature by the American Association of Engineers. Practically its only proponents at the hearing were the members of the American Association of Engineers and its counsel, the proposed bill being opposed by representative members of the Boston Society of Civil Engineers, the Boston sections of the American Society of Mechanical Engineers, American Institute of Electrical Engineers, American Institute of Heating and Ventilating Engineers, the American Institute of Mining and Metallurgical Engineers, and the Northeastern Section of the American Chemical Society, the American Institute of Chemical Engineers, the Boston Society of Landscape Architects, and the Engineering Society of Western Massachusetts. Both the principle of licensing and the form in which the bill was drawn were objected to. The bill as drafted conformed substantially to the model law prepared by Engineering Council.

The hearing upon the proposed bill was held before the legislative committee on mercantile affairs. A count of those present at the hearing by the legislative committee showed nineteen in favor and eighty-nine against the proposed bill. The legislative committee, therefore, recommended that the bill be referred to the next annual session of the legislature, this recommendation being adopted in the senate, Feb. 24, and in the house, March 3.

In reporting to its board of government at the recent annual meeting, the committee on licensing of the Boston Society of Civil Engineers recommended the continuation of it or a similar committee to study further the matter of licensing engineers, and also recommended that other engineering or architectural societies be invited to join in such a study.

Personnel Research Federation Is Organized

Under the auspices of the National Research Council and Engineering Foundation, in the building of the National Research Council, Washington, was effected March 15 the organization of the personnel research federation. This federation includes in its membership scientific, engineering, labor, management and educational bodies. The federation has been organized to bring about interchange of research information among the numerous organizations who are engaged in personnel research.

It is reported to the new federation by the bureau of labor statistics, of the Department of Labor, that there are 250 such organizations in the United States. The federation will collect research information, will encourage research through individuals and organizations and will co-ordinate research activities.

Temporary officers were elected as follows: Chairman, Robert M. Yerkes, National Research Council; vice-chairman, Samuel Gompers, American Federation of Labor; treasurer, Robert W. Bruere, Bureau of Industrial Research; secretary, Alfred D. Flinn, Engineering Foundation; acting director, Beardsley Ruml, assistant to the president of the Carnegie Corporation of New York.

The aims of the new organization are increased efficiency of all the personnel elements of industry—employer, manager, worker—and improved safety, health, comfort and relationships.

Highway Educational Bureau To Produce Road Film

James W. Brooks has resigned from the Federal Highway Council to become director of the American Highway Educational Bureau. Mr. Brooks announces that the change was made for the purpose of conducting highway educational work along more intensive and effective lines, supporting the federal-aid principle, and looking to the construction of state and county systems as the logical first step in highway development.

Production of "The Changing Road," the first standard road film ever undertaken, is now under way. The film is to be comprehensive in scope and official in character and will be released during the early summer. It will portray the evolution of road construction and administration from primitive to modern methods, with the aim of educating the public away from cheap construction and showing taxpayers the real work which their state highway officials are striving to do in their behalf.

Viewpoint of Public Service in Engineering Courses

With the reorganization through which the College of Engineering of the University of Maryland is passing, it is announced that the general purpose will be to broaden the courses of instruction for the better preparation of engineering students for public service. The new university catalog states that it is not the intention that the subject matter of the courses shall be essentially different, but that the viewpoint of the student and the application of the principles will be that of public service. The view is held that the large public works program contemplated in practically every state makes urgent the demand for engineers trained for such work and that modern engineering education affords suitable preparation for many callings in both public and private life outside of the engineering profession. A. N. Johnson is dean of the College of Engineering.

Illinois Central Engineers Begin Educational Work

Education of engineers on the Illinois Central, to establish closer contact with the management and to prepare men for high executive positions, was begun March 24. The Illinois Central Section of the American Association of Engineers, under whose auspice the work is to be carried on, consists of 125 railroad professional engineers.

Professional Society Organized in Spain

Engineers of Catalonia, a province of Spain, have organized a professional society somewhat similar to the American Association of Engineers, under the title (translated) General Technical Society of Catalonia. Its present membership appears to consist largely of Barcelona men. According to a statement in its introductory bulletin, just issued, the society is organized for cultivation of the common interests of engineers, for participation in bringing about a solution of the "social struggle of our times," for contributing to the settlement of the conflict between employing and laboring classes, and for upholding the profession of engineering in public life. Manuel Vidal is president, Alejandro Homdedeu is secretary, and Manuel Escude is corresponding secretary. The addresses of the two latter are Calle San Salvador 61, and Calle Laforja 12, Barcelona.

Tell Public About Engineering Problems at St. Paul

As a result of the activity of the St. Paul (Minn.) Engineers Society, the *Daily News* of that city is publishing in its Sunday edition a series of articles designed to inform the public regarding the most important local engineering problems. On March 21 the *Daily News* carried a story on the alternative projects of widening of the existing Robert St. bridge or building a new bridge at Sibley St. A feature of the service just inaugurated is the offer of the society to answer, through the medium of the daily press, engineering questions of general interest.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

AMERICAN ASSOCIATION OF ENGINEERS, Chicago; Seventh Convention, Buffalo, N. Y., May 9, 10 and 11.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; Annual Convention, Houston, Texas, April 27-30.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, New York; Spring meeting, Chicago, May 23-26.

AMERICAN WATER WORKS ASSOCIATION, New York; Convention, Cleveland, June 6-10.

The New York Post, Society of American Military Engineers, at its meeting April 13 at New York, will discuss "Military and Engineering Defense of New York—Its Methods and Principles as Modified by World War Lessons." The meeting will be addressed by Col. John McA. Palmer, U. S. A. on "The Scheme of Coast Defense as Now Formulated" and by Col. Samuel G. Shartle, U. S. A., G-3, 2nd Corps Area on "Special Tests of Coast Defense Scheme and Relation of Committee on Public Safety." The New York Sections of the Am. Soc. C. E., Am. I. M. M. E., A. S. M. E., A. I. E. E. and the S. A. E. have been invited to attend this meeting.

The Mohawk Valley Engineers Club, at its meeting in Utica, N. Y., March 17, was addressed by W. S. Murray, chief chemical engineer, Oneida Community, Ltd., on "Research."

The Engineers' Club of Philadelphia on April 16 will tender to Herbert Hoover, Secretary of Commerce, a dinner at the Bellevue-Stratford Hotel, Philadelphia.

PERSONAL NOTES

HENRY G. SHIRLEY will resign May 1 as secretary of the Federal Highway Council, Washington, D. C., to accept the position of road and sanitary engineer of Baltimore County, with headquarters at Towson, Md.

C. L. DEWEY, formerly president of the Traylor-Dewey Contracting Co., is now second vice-president of the MacDonald Engineering Co. in charge of operations in the east, with headquarters in New York. The firm specializes in reinforced concrete grain elevators, flour and feed mills, cold storage warehouses, cement mills and coal handling plants.

H. C. NUTTING, manager of the Pittsburgh Testing Laboratory, Cincinnati, for the past six years, has recently organized a new company under the name of the H. C. Nutting Co., Cincinnati, Ohio. Mr. Nutting is highway engineer for the Cincinnati Automobile Club and will specialize in highway construction.

GEORGE C. DIEHL has been reappointed county engineer of Erie County, N. Y., with headquarters at Buffalo, N. Y.

ALBERT L. UPHAM, formerly with Stone & Webster, has been reinstated as inspector of construction in the U. S. Navy Department, Bureau of Yards & Docks, and assigned to duty at U. S. Naval Base, San Diego, Cal.

ARCHER P. CROSLEY, assistant supervisor of the Philadelphia & Reading R.R. at Trenton Junction, N. J., has been promoted to supervisor with headquarters at Coatesville, Pa. He has been in the employ of the above company since 1917.

F. W. BILITZ, assistant supervisor of the Wilmington and Columbia division, Philadelphia & Reading R.R., has been transferred to Trenton Junction, N. J., succeeding A. P. Crosley as assistant supervisor.

EARLE B. MOSS, formerly junior civil engineer at the U. S. Engineer Office, Buffalo, N. Y., has been appointed to the newly created office of appraiser in the Bureau of Assessment and Taxation, Niagara Falls, N. Y.

THE MID-WEST ENGINEERING CO., Coffeyville, Kan., has been organized by G. A. Barcroft, formerly assistant construction engineer Sinclair Refining Co., Coffeyville; associated with him are engineers of experience in the design and construction of large engineering projects in the United States and Central and South America. The firm will engage in general engineering practice, including buildings, power development, water supply, dams and reservoirs, surveys maps, estimates, designs and investigations. Mr. Barcroft was with the Isthmian Canal Commission at Panama for four years in the capacity of rodman, levelman, transitman and general foreman. In 1919 he was superintendent of construction at the government's water-power project on the Tennessee River at Muscle Shoals, Ala.

J. C. MCLEAN has been appointed county engineer of Woodbury County, Iowa.

R. T. WYKOFF, recently in private engineering practice and for a number of years with the Truscon Steel Co., St. Louis, Mo., is again connected with this company as engineer in the St. Louis office.

GEORGE F. MCGONAGLE has resigned as state engineer and in company with C. J. Ullrich, deputy state engineer, will open consulting engineering offices in Salt Lake City, Utah.

LIEUTENANT-COLONEL GUSTAVE LUKESH, Corps of Engineers, U. S. A., has been confirmed as a member of the Mississippi River Commission.

GLENN S. WHITE has been appointed city engineer of Fort Morgan, Col.

H. J. HEMSTREET, since 1919 engaged in the inspection of Montana and Idaho Federal Aid projects, U. S. Bureau of Public Roads, with the exception of three months when he was assigned to the bureau's special study of the California State system of paved roads, has been transferred to District 9, U. S. Bureau of Public Roads, with headquarters in Troy, N. Y. He will be engaged in the inspection of post road projects.

H. B. CASSIN, formerly assistant engineer of Jefferson County, Ky., is now engineer for the Louisville Real Estate and Development Co., Louisville, Ky., at present engaged in subdividing and selling Camp Zachary Taylor.

A. T. BAGGS, formerly with the Globe Grain and Milling Co., Ogden, Utah, has accepted a position with the Pioneer Sugar Co., Whitney, Idaho, as engineer and assistant superintendent of construction.

WILLIAM H. SMITH, recently connected with the sewer and paving improvement work in Tarboro, N. C., is now with the firm of P. G. Ligon & Co., on a large sewer and paving contract in Washington, N. C.

GUNNI JEPPHSEN, formerly chief engineer of the Strauss Bascule Bridge Co., has joined the Chicago Bascule Bridge Co., Chicago, Ill., as associate engineer. He was connected with the Strauss company for 12 years, from its inception until 1917, and since then has been engaged in industrial plant work as structural engineer of the Leonard Engineering Co.

BUSINESS NOTES

ROBERT C. WELLER has been appointed general sales manager of the Lakewood Engineering Co.

E. F. PEGG, who has been connected with manufacturers of constractors' equipment in Cleveland and vicinity for the past twelve years, has opened an office in Cleveland for the purpose of handling contractors' equipment.

THE MORRISON & RISMAN CO., jobbers in new and relaying rails and accessories of Buffalo, N. Y., has opened an office in Philadelphia, Pa., with R. B. Morrison as district manager.

THE RUBEROID CO. is the new name of the company formerly known as The Standard Paint Co., New York, manufacturer of Ruberoid roofing and weatherproofing products.

THE GENERAL CHEMICAL COMPANY has announced that J. H. Libberton, formerly manager of the Service Bureau, Universal Portland Cement Co., has joined its staff. He will handle service and sales of Hard-N-Type, a chemical crystalline hardener for concrete

M. L. NORTHROP, recently connected with the Pittsburgh Meter Co., has been appointed New England representative, Warren Foundry & Machine Co., with offices at Boston, Mass.

THE CHICAGO PNEUMATIC TOOL CO. has appointed R. F. Eissler, formerly district manager, Pittsburgh branch, assistant to the vice-president with headquarters in New York.

E. C. MORSE, former director of sales, War Department, Washington, D. C., is the head of the newly organized Foreign Trade Supply Corporation, with its main offices in New York. With Mr. Morse, the president, are A. LaMar, until Dec. 31, last, assistant director of sales, War Department, who is vice-president; Paul Klopstock, of New York, chairman of the board of directors, and Arthur Mayer of New York, counsel. The corporation will engage in a general merchandise brokerage exporting and importing business, and in the buying and selling of foreign securities.

THE STEARNS CONVEYOR CO., Cleveland, Ohio, has been organized by Earl D. Stearns, formerly vice-president and sales manager of the H. K. Ferguson Co., Cleveland. The new company will handle elevating, conveying, screening, transmission machinery and accessories. The officers are: President, Earl D. Stearns; vice-president and superintendent of shops, W. E. Phillips; secretary and treasurer, G. H. Whitman.

THE NATIONAL STEEL FABRIC CO. has opened a sales office in the Mutual Building, Kansas City, Mo., in charge of H. W. Pobinson.

WENDELL M. BUTTS has accepted the position of sales representative and resident engineer at Manila, P. I., with William H. Anderson & Co., agents for the Truscon Steel Co., Youngstown, Ohio.

HYLAND-JENCKS, landscape engineers and contractors, New York, has been incorporated for the extension of its landscape construction and planting work along the East coast from Boston to Miami, Fla., and to develop its metropolitan branches in an intensive manner. H. A. Jencks is president of the new corporation.

WILLIS LERICHE, formerly district sales manager with the Cement Gun Co., Kansas City, has been elected vice-president of the Traylor-Dewey Contracting Co., Allentown, Pa. This company specializes in contract work with cement guns and is connected through its board of directors with the Cement Gun Co.

London Guild of Builders Is Factor in Housing

Contracts Held More Than $3,000,000—Insurance and Materials Supplied By Co-operative Societies

By C. H. S. Tupholme
London, England

After seven months of operation the London Guild of Builders has secured contracts aggregating $750,000 in value, extending over a period of two years. It has also proven a contending factor in the contracting field, for, according to Malcolm Sparks, its general manager and secretary, from the first inclination to ridicule it the building employers are now fighting it, endeavoring to squeeze it out of business.

As matters stand in the British building trades the contemplated action of the master builders may benefit the guild considerably. The building employers have threatened a national lock-out in the event of the operatives declining to accept the Government's scheme for the dilution of the building trades. If a national lock-out actually takes place, it may lead to the placing of more building contracts with the Guild and materially increase the supply of labor from which it can draw. As it is the general manager informs me that for the guild purposes there is a wealth of labor already available for the contracts in hand, which includes architects, surveyors and members of the building trades unions. It may be added that the guild has the wholehearted support of the Royal Institute of British Architects.

Guild Organization

The London Guild of Builders was set up by a vote of the National Federation of Building Trades Operatives (London District Council) last year. The purpose of this guild is to develop its organization by means of three distinct types of committee, each with its own sphere of operations and each with clearly defined functions. They are:

1. *The Area Guild Committee*, of which there are 11 covering London and the outlying districts, representing the trade-union branches and the approved groups in each area and concerned mainly with the organization of the labor for each local contract, and with the social development of the guild movement.

2. *The Regional Guild Committees* (*e.g.*, London) representing the trade unions, the groups and the area committees in each region; registered as legal entities on a standard code of rules and acting as contractors with all the necessary technical and administrative services for estimating contracts and carrying them through.

3. *The National Guild Committee* representing the national trade unions, the approved functional organizations and the regional guild committees, and concerned mainly with the purchase, manufacture and supply of materials, the co-ordinated use of plant and equipment, the arrangement of credit, and the central reserve funds for continuous guild pay, technical research and insurance.

The guild committee consists of representatives elected by the trade unions affiliated with the district section of the National Federation of Building Trade Operatives, and any other trade unions or groups of building-trade workers within the district, whether administrative, technical, clerical or operative. Each trade union or group elects one member. Approved groups have already been formed by the architects and surveyors, and groups of civil engineers and of sculptors and decorative artists are under consideration.

Each member of the guild committee holds one shilling share and deposits with his electors a signed open transfer, thus giving them power to replace him at any time.

The guild committee is responsible for the appointment and removal of managers and general foremen and for the fixing of their salaries. General foremen are nominated by the area committee and ratified by the guild committee. Departmental foremen are elected by the guildsmen of the trade concerned.

Contract Methods

The guild form of contract as approved by the Ministry of Health for Municipal Housing Schemes creates a triple alliance under which the guild carries out the whole of the work. The Co-operative Wholesale Society undertakes to supply the materials, and the Co-operative Insurance Society guarantees the due performance of the contract, the liability under this head being, however, limited to 20 per cent of the estimated cost. The price paid by the local authority is the prime cost of material and labor at standard rates, with the addition of £40 per house to enable the guild to guarantee continuous pay to its workers in all contingencies, and 6 per cent calculated upon the estimated cost, to provide for plant, head-office administration and, if necessary, for interest upon hired capital. The estimate of cost is given by the guild and approved by the Ministry of Health for each contract. The initial cost of plant and equipment is covered by an advance from the Co-operative Wholesale Society's bank, secured against payments due under the contract. All other problems of finance are reduced to manageable proportions by the provision of payments weekly by the local authority, both for labor and materials delivered, and for the authorized guild charges.

London's first guild contract was made with the Walthamstow Urban District Council, by the terms of which contract the guild undertakes the whole of the work involved in the building of 400 houses to plans approved by the Ministry of Health. The houses are of brick with slate roofs, two stories and four-family structures, each with five rooms, kitchen bath and hall.

The London Guild has also secured contracts to build 132 houses at E[illegible] field and 190 at Greenwich on the sam[illegible] conditions. Designs for these hous[illegible] can, if necessary, be altered in deta[illegible] as long as the basis of the Minist[illegible] scheme is adhered to.

Possible Extensions

Though no building costs are yet available, the Minister of Health has promised that if the cost of the first guild-built houses is satisfactory, and a suitable form of contract can be drawn up, the present order which limits guild contracts in the London area to four will be rescinded, and no obstacle will be placed in the way of guild contracts wherever a local authority desires to employ the guild. The publication of the guild costs will now only be a matter of a few weeks.

The guild is also prepared to submit tenders for other forms of building-trade work such as painting, decorating and the erection of schools and other public buildings. In fact, the guild will shortly commence operations on a joinery factory in London.

The guild is now working on designs of its own for the most up-to-date labor-saving dwelling of 1,400 sq.ft., 700 sq.ft. to each of its two floors. A house to the completed designs will be built and will then be thrown open to the inspection of local authorities.

It is interesting to note that the conception of this guild originated with the rank and file and did not begin with the formation of a guild committee. Thus the growth has been upward instead of downward. So far there are but two building guilds, the London body and the Manchester Guild, both working on exactly the same principles.

Cheaper Building in Britain

(*London Correspondence*)

The fall in the builders' wages and the decreased cost of building materials is shown in the tenders accepted for the erection of houses by Leicester Rural Council. The price for parlor houses as shown in this tender is £772; a few months ago the prices of these dwellings were from £1,000 to £1,200 each. The dwellings are to be built to the standard specifications and accommodation as laid down by the Ministry of Health.

Joint Legislative Body to Make Building Inquiry in Chicago

Preliminary plans have been made for an investigation of building conditions in Chicago by a joint legislative committee of fourteen. Senator John Dailey of Peoria, chairman of the committee, is reported to have said that he believes extortionate methods have been followed in Chicago which, upon investigation, may reveal a situation existing in that city worse than that brought to light by the recent investigations in New York City by the Lockwood joint legislative committee on housing.

President Confers With Heads of Railroad Unions

This week President Harding has held a series of conferences with the heads of the railway brotherhoods, at which, it is presumed, the status of the so-called national agreements was discussed. On April 4 B. M. Jewell, president of the railway employees department, American Federation of Labor, and A. B. Garettson, former president of the Brotherhood of Railway Trainmen, called on the President, followed by W. S. Carter, president of the Brotherhood of Locomotive Firemen and Enginemen the next day. It is understood that the case of the brotherhoods will be heard previous to the President's calling railroad executives. It is not known whether the President will take any action in the matter of reducing railway wage scales or whether it will be left to the Railway Labor Board and the Interstate Commerce Commission.

Crisis Expected in the British Building Trades

(*London Correspondence*)

A crisis is expected soon in the building trade in England. It is generally expected that the employers will declare in favor of the government's scheme for the introduction of 50,000 unemployed ex-service men into the trades, while the unions are generally against the proposition altogether, a few considering the scheme with reservations. The government scheme has been discussed in private at a conference of the executives of the various unions affiliated with the National Building Trades Operatives' Federation. It is reported that fresh proposals, which have not yet been disclosed, have been made by the government, and these have been submitted to a ballot of the master builders with an executive recommendation for their acceptance. Meanwhile the outlook is not very hopeful. It is certain that the system of payment by results will be resisted tooth and nail by the operatives' federation.

In the meantime a conference of the National Building Operatives' Federation has endorsed the proposed wages sliding scale, which provides that reduction will take place at the rate of 1d. per hour for each 13 points fall in the cost of living, and ½d. per hour for each 6.5 points, with advances in wages of similar amounts for rises of 10 and 5 points respectively.

It was proposed at this conference that 170 per cent above the pre-war cost of living be taken as the basic figure, and as the last official return shows the cost of living index to stand at 153, a reduction in wages is imminent.

School Construction Leads

Owing to the large number of educational buildings put under contract miscellaneous building contracts aggregated during the past week $11,331,126 for sixty-two projects. Apartments in that figure approximate $1,100,000. An increase in the number of small public works projects is noted and in bids advertised it is apparent that road construction is opening up generally. Illinois opened test bids on several road projects April 5, and Pennsylvania opened bids on 150 miles of roads, details of which are found in the construction news of this week.

Arbitration of Boston Building Strike Blocked

After the Boston Building Trades Council had agreed April 1 in an all-night meeting to accept the proposal of the State Board of Conciliation and Arbitration to act in the settling of the building trades dispute which has tied up Boston building since early in the year, announcement was made by the chairman of the arbitration board that the Building Trades Employers Association of Boston had decided not to submit its case. The reason given was that not all the constituent members of the Building Trades Council had agreed to the arbitration plan and that the employers would not consent to arbitration proceedings unless a guarantee were given that all the constituent members of the council would be bound by the general action.

Brindell Begins Prison Term

Robert P. Brindell, president of the New York Building Trades Council, was taken to Sing Sing April 4 to begin a sentence of from five to ten years for extortion. His conviction was an outgrowth of testimony adduced at the recent investigation of building conditions in New York City, carried on by the Lockwood committee.

New York School Program to Cost $52,387,000

The Board of Estimate of New York City recently adopted the building program of the Board of Education calling for the construction of 53 new buildings and additions to several existing schools, the total cost to be $52,387,000.

Labor Rates and Conditions Throughout the Country

DESPITE the talk of "liquidation" of labor, we have to report decreases only in Seattle and Denver. In Seattle the majority of building projects under way are controlled by the Master Builders' Association, which maintains open shop. Union bricklayers are paid $9 per day; non union, $8. Non union hodcarriers receive $5.60 against the union rate of $7. Common labor has declined from $5@$6 to $4 @$4.80. Cement finishers receive $6.40.

The Colorado Industrial Commission has granted permission to Denver contractors to make reductions in wages in the building crafts as follows: Bricklayers from $12 to $11 per day; carpenters, from $9 to $8; hoisting engineers, from $9 to $8; pile drivers and structural iron workers, from $9.25 to $8; and common labor on buildings, from $5 to $4 a day. Reductions from $9 to $8 were also authorized for sheet metal workers, and cement finishers; from $9.50 to $8.50 for steam fitters, plumbers and gas fitters; glaziers from $6.60 to $6 and electrical workers from $8.20 to $7.20. The changes are effective April 1. Hod-carriers' wages remain at $6, $6.25 and $6.50 a day. Similar adjustments are being negotiated throughout the state, using the Denver rates as the basis. The crafts accepting the reductions are the hoisting engineers, pile drivers, structural iron workers, common labor, sheet-metal workers, cement finishers, steam fitters, plumbers and gas fitters, glaziers and electrical workers. The bricklayers and carpenters have not yet accepted and a strike by these crafts appears probable. No strikes are on in Denver. Employment in the building trades has increased approximately 10 per cent in the last two weeks. A large amount of construction work has been held up waiting these adjustments and heads of the labor organizations express the opinion that there will be a shortage of labor in all crafts shortly after May 1.

That the union schedule in Cleveland is not the maximum is shown by a letter just received from a well known contractor in that city. Here is a comparison of hourly union rates (effective until May 1) with the rates our correspondent has been paying for the last year:

	Union	Correspondent
Bricklayers	$1 00	$1 25
Carpenters	90	1 25
Hoisting engineers	1 00	1 25
Hod-carriers and common labor	57½	87½

New Orleans reports that there will be no change in the wage scale until June 1, when the labor agreements expire. The situation was explained at length in *Engineering News-Record* of March 31, p. 576.

The Minneapolis Builders' Exchange reports considerable of cutting under the official scale, despite agreements with the union. Common labor is at 50c. with exceptions both above and below that figure. Following is the official scale, with the scale proposed by contractors for general observance May 1, and already operative on many jobs:

	Official	New Scale
Bricklayers	$1 25	$1 00
Carpenters	1 00	80
Hoisting engineers	1 00	80
Hod-carriers	75	65
Structural iron workers	1 00	80
Common labor	60	50

Many wage cuts are announced. Master builders of Passaic and Bergen counties will cut 10 to 20 per cent on May 1. The Building Trades Employers' Association of Essex County, N. J., will reduce wages by 10 to 20 per cent in ten of thirteen trades. The wages of carpenters and painters will remain unchanged, but bricklayers, masons and plasterers will be cut from $10 to $9; plumbers, from $10 to $8; ironworkers, from $9 to $8; hod-carriers and mason laborers, from $7 to $5.60. The Carpenters' District Council of St. Louis, representing more than 5,000 men, on March 25 rejected a proposition to reduce the rate from $1.25 per hour to $1, the secretary claiming that labor is 30 per cent more efficient than when work was plentiful. The union of hoisting engineers of St. Louis, with 135 members, voted unanimously to reject a proposed 20 per cent decrease, the Painters' District Council, of 2,000 members, rejecting a similar proposal.

Building contractors in Rochester, N. Y., are awaiting official notification by the Building Trades Council of its rejection of their offer of a "renewal of existing agreements with a 15 per cent decrease." A leading general contractor is reported to have said: "The contractors have pledged themselves to do their share, also, in a reduction of building costs by a proportionate lessening of their profits. In requesting their employees to accept lower wage scales they have no mercenary motive." Current wage rates are as follows:

S means scarce; E, enough; P, plentiful

Cities	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor
Atlanta	$0.90P	$0.70P	$1.00P	$0.30P		$1.00P	$0.25P
Baltimore	1.25	.80P	.87½P	.46@.54P	$0.74P	1.00P	.30 @.35Pz
Boston	.90S	.90P	.90P	.60P	.90	.90P	.55P
Cincinnati	1.25E	.90E	1.00P	.40E	1.00S	1.00E	.60E
Chicago	1.25	1.25				1.25	1.00
Cleveland	1.00S	.90S	1.00E	.57½E	.80E	1.00E	.57½E
Dallas	1.00P	1.00P	1.00E	.60E	1.00E	1.00E	.50@.75P
Denver	1.37½	1.00	1.00	.75@.81¼	1.00	1.00	.50
Detroit	1.25P	.85@1.00P	1.10P	.70P	1.10P	1.25P	.50@.60P
Los Angeles	1.25P	1.00P	1.00P	1.12½P	1.00P	1.00P	.75P
Minneapolis	1.00P	.80P	.80P	.65P		.80P	.50P
Montreal	.90P	.65P	.60P	.40P	.50P	.65P	.35@.45P
New Orleans	1.00P	1.00P	1.00P	.65P	1.00P	1.00P	.50P
New York	1.25	1.12½	1.25	.87½	1.12½	1.12½	.75@.80
Pittsburgh	1.50P	1.25P	1.12½P	1.00P	1.00P	1.25P	.80P
St. Louis	1.25P	1.25P	1.25P	.85P	1.00P	1.25P	.67½P
San Francisco	1.25P	1.12½P	1.12½P	1.00P	1.12½P	1.12½P	.81¼P
Seattle	1.12½	.80@.87½	.87½@.90	.70	1.00	.90	.50@.60

Monthly Prices of Construction Materials

Ups and Downs of the Market

Pig Iron—Prices $1.50@$3 lower than last month, with market stagnant.

Steel Rails—Moderate demand for light rails by coal companies. We quote a lower price than last month, at Pittsburgh.

Railway Ties—Latest prices of plain and creosoted ("empty cell") cross-ties in Chicago and San Francisco, and of untreated ties in St. Louis. On the Pacific Coast ties are usually purchased and used untreated, except by the Santa Fé and the Southern Pacific railway companies. The Southern Pacific uses the Burnett or zinc chloride process over its entire system, the railway doing its own treating. The Santa Fé applies the Boulton or boiling-in-vacuum process in Arizona and Southern California. We quote on ties treated by the Rueping or empty-cell process.

Pipe—While there has been no mill change, New York dealers have announced a piece cut. The only change in sewer pipe is a cut in Baltimore. Denver quotations on sewer pipe are again available.

Road Oils and Asphalt—Road oils down ½c.@1c. in New York. Asphalt down in New York, Minneapolis and Atlanta. Maurer, N. J., quotations are again offered.

Wood Blocks—Down in New York and Minneapolis.

Sand, Gravel and Stone—Gravel is down 50c., to $2.50, in New York. Other decreases in New Orleans and Atlanta. Crushed stone down in Dallas, Atlanta and Montreal.

Cement—Price in New York remains $3.10 net, with the change for bags now 40c. per bbl. instead of $1 as heretofore. We quote the cement companies' price alongside dock to dealers, $2.40 net. Decrease in New Orleans.

Reinforcing Material—Triangle mesh quotations have been thoroughly checked and are correct as they stand. Steel bars sell for as low as **$2 per 100 lb.** in large lots, Pittsburgh; $2.38 for mill shipments, New York. We quote the minimum and the Steel Corporation prices.

Common Brick—Last week the wholesale price of brick alongside dock, New York, was reduced from $18 to $15@$17; but the delivered price to contractor remains at $21.70, which includes the dealers' profit of 10 per cent and the cartage. Decrease reported by Dallas, New Orleans, Minneapolis and Montreal.

Hollow Tile—Down in New York and St. Louis; up in New Orleans and Atlanta. Our New Orleans correspondent has not been able to determine the reason for the 3c. per block advance in that city.

Structural Shapes—We show a range of $2@$2.45, at Pittsburgh mill. Sharp decreases on deliveries from New York, Chicago and St. Louis warehouses. Rivet down at mill, Pittsburgh, and in St. Louis warehouses. Market dull.

Steel Sheets—General decrease in St. Louis. Blue annealed down in San Francisco. Market dull.

Lumber—The decline continues, with conditions unsteady. Demand flat. Wholesale prices down $7 in New York since last month. Chicago reports "no change," but urges caution as to price. Decreases in Seattle, New Ordleans and Baltimore. Douglas fir down $1 in San Francisco.

Price advances since last month are indicated by **heavy type**; declines by *italics*.

PIG IRON—Quotations compiled by The Matthew Addy Co.:

	Current	One Year Ago
CINCINNATI		
No. 2 Southern	$30.50	$44 60
Northern Basic	27.52	42 80
Southern Ohio No. 2	30.50	43 80
NEW YORK, tidewater delivery		
Southern No. 2 (silicon 2.25 to 2.75)	36.51	47 70
BIRMINGHAM		
No. 2 Foundry	26.50	41 00
PHILADELPHIA		
Eastern Pa., No. 2X, 2.25@2.75 sil	27.00*	45 65*
Virginia No. 2	28.00*	43 25*
Basic	26.25†	43 00†
Grey Forge	27.00*	42 50*
CHICAGO		
No. 2 Foundry Local	25.00@27.00	43 00
No. 2 Foundry Southern	32.92	46 00
PITTSBURGH, including freight charge from the Valley		
No. 2 Foundry Valley	26.96	43 65
Basic	26.86	42 90
Bessemer	27.00	43 40

*F.o.b. furnace. † Delivered.

RAILWAY SUPPLIES

STEEL RAILS—The following quotations are per ton f.o.b. Pittsburgh and Chicago for carload or larger lots. For less than carload lots 5c. per 100 lb. is charged extra:

	Pittsburgh		Chicago	
	Current	One Year Ago	Current	One Year Ago
Standard bessemer rails	$45 00	$45 00	$45 00	$45 00
Standard openhearth rails	47 00	47 00	47 00	47 00
Light rails, 8 to 10 lb.	2.20@2.55*	2 585*	2 45@3 00*	2 585*
Light rails, 12 to 14 lb.	2.15@2.50*	2 54*	2 41@2 95*	2 54*
Light rails, 25 to 45 lb.	2.10@2.45*	2 45*	2 32@2 85*	2 45*

*Per 100 lb.

RAILWAY TIES—For fair-sized orders, the following prices per tie hold:

	6 In. x 8 In. by 8½ Ft.	7 In. x 9 In. by 8 Ft. 6 In.
Chicago, White Oak	$1 60	$1 75
Chicago, Hardwood and Red Oak	1 40	1 55
Chicago, Empty Cell Creosoted	2 00	2 25
San Francisco, Green Douglas Fir	.80	1.12
San Francisco, Empty Cell Creosoted, Douglas Fir	1.76	2.48

For ties on standard "railroad administration" specifications, f.o.b. cars, St. Louis:

	White Oak	Red Oak	Pine and Sap Cypress
Grade 3	$1 35	$1 20	$1 10
Grade 2	1 25	1 10	1 00
Grade 1	1 15	1 00	90

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh for carload lots, together with the warehouse prices at the places named:

	Pittsburgh				San Francisco
	Current	One Year Ago	Chicago	St. Louis	
Standard spikes, ⅝-in. and larger	$3.30@3.65	$3 35	$3 40	$4 87½	$6.75
Track bolts	4.60@5.50	4 90	4 60	5 75	7.75
Standard section angle bars	2.45@2.75	2 75	2 75	4 05	4.50

PIPE

WROUGHT PIPE—The following discounts are to jobbers for carload lot on the Pittsburgh basing card of Mar. 21, 1919:

BUTT WELD

Steel			Iron		
Inches	Black	Galv.	Inches	Black	Galv.
¼ to 3	54 to 57½	41½ to 44	¼	15½ to 25½	4½ to 11½
			⅜	19½ to 29½	11½ to 11½
			½ to 1¼	24½ to 34½	8 to 18½

LAP WELD

2	47 to 50½	34½ to 38	2	20½ to 28½	6½ to 14½
2½ to 6	50 to 53½	37½ to 41	2½ to 6	22½ to 30½	9½ to 17½
7 to 12	47 to 50½	33½ to 37	7 to 12	19½ to 27½	6½ to 14½
13 and 14	37½ to 41				
15	35 to 38½				

BUTT WELD, EXTRA STRONG, PLAIN ENDS

¼ to 1¼	52 to 55½	39½ to 43	¼ to 1¼	24½ to 34½	9½ to 19½
2 to 3	53 to 56½	40½ to 44			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	45 to 48½	33½ to 37	2	21½ to 29½	8½ to 16½
2½ to 4	48 to 51½	36½ to 40	2½ to 4	25½ to 33½	11½ to 19½
4½ to 6	47 to 50½	35½ to 39	4½ to 6	22½ to 30½	10½ to 18½
7 to 8	43 to 46½	29½ to 33	7 to 8	14½ to 22½	2½ to 10½
9 to 12	38 to 41½	24½ to 28	9 to 12	9½ to 17½	5½ to 2½

STEEL—From warehouses at the places named the following discounts hold for steel pipe:

	Black		
	New York	Chicago	St. Louis
¼ to 3 in. butt welded	50%	54@40%	45½%
2½ to 6 in. lap welded	50%	50@40%	41½%

	Galvanized		
	New York	Chicago	St. Louis
¼ to 3 in. butt welded	45%	40½@30%	30½%
2½ to 6 in. lap welded	50%	37½%@27½	27½%

Malleable fittings, Class B and C, from New York stock sell at net list prices. Cast iron, standard sizes, 50 and 5% off.

CAST-IRON PIPE—The following are prices per net ton for carload lots:

	New York					
	Current	One Month Ago	One Year Ago	Chicago	St. Louis	San Francisco
4 in.	$73 30	$73 30	$75 30	$69 10	$66 70	$92 65
6 in. and over	63 30	63 30	72 30	64 10	61 70	87 65

Gas pipe and Class "A," $4 per ton extra; 16-ft. lengths, $1 per ton.

CLAY DRAIN TILE—The following prices are per 1000 lin. ft.:

	New York					
Size, In.	Current	One Year Ago	St. Louis	Chicago	San Francisco	Dallas
3	$50 00	$35 00	$60 00	$50 00		$55 00
4	60 00	51 00	70 00	70 00	$90 00	65 00
5	90 00	65 00	90 00	90 00	115 00	84 00
6	115 00	90 00	120 00	110 00	150 00	110 00
8	185 00	130 00	185 00	160 00	250 00	181 00

SEWER PIPE—The following prices are in cents per foot for carload lots:

Size, In.	New York Current Delivered	Pittsburgh	St. Louis	Chicago	San Francisco	Dallas
3	$0 24	$0 132		$0 15	$0 14	
4	24	132		15	175	$0 18
5	36	198		225	21	
6	36	198	$0 17½	225	245	25
8	56	308	25	35	35	35
10	84	462	35	525	49	
12	1 08	594	45	625	63	80
15	1 61	792	68	90	1 05	
18	2 30	1 10	88	1 25	1 47	
20	2 76	1 32	1 20	1 50	1 96	
22	3 68	1 98		2 00		
24	4 14		1 56	2 25	2 52	2 40
27			2 75	4 50	3 50	
30			3 40	5 50	4 20	
33			4 35	6 75		
36			4 50	7 00		

	3	5	8	12	24	36
Boston	$0 21	$0 315	$0 49	$0 945	$3 15	$8 7125
Minneapolis			42	77	2 45	5 66
Denver		15	30	50	1 95	
Seattle			40	80	2 88	
Los Angeles	11*	165*	275	495	1 65	
New Orleans		165	333	561	2 15	
Cincinnati	15½	2205	44	6615	2 205	6 15
Atlanta	11*	165*	27	47	1 86	
Montreal, *delivered*	30*	45*	70	1 35	4 50	6 50
Detroit	138	2115	329	621	2 56	6 625
Baltimore		26	41	81	2 66	
Baltimore, *delivered*		28	44	86	2 84	

4-in., 6-in., 30-in. respectively.

ROAD AND PAVING MATERIALS

ROAD OILS—Following are prices per gallon in tank cars 8,000 gal. minimum, f.o.b. place named:

		Current	One Year Ago
New York, 45% asphalt	(at terminal)	$0.07	$0 11½
New York, 65% asphalt	(at terminal)	.07	11½
New York, binder	(at terminal)	.07½	11½
New York, flux	(at terminal)	.07	.12
New York, liquid asphalt	(at terminal)	.08½	06½
St. Louis, 40% asphalt		11	08
Chicago, 40-50% asphalt		06	08½
Chicago, 60-70% asphalt		06½	0725
Dallas, 40-50% asphalt		10	07
Dallas, 60-70% asphalt		13	08
Dallas, 75-90% asphalt		15	10
San Francisco, binder, per 42-gal. bbl.		15.00	2 25

ASPHALT—Price per ton in packages (350-lb. bbl. or 425-lb. drums, and in bulk in carload lots

	Package	Bulk
New York (Bayonne, N. J.)	$28.00	$18.00
Boston	No quotations	
Chicago	28 50	21 00
San Francisco	21 50	15 00
Dallas	35 00	27 00
Seattle	27 50	
Denver		50@70
Minneapolis		25.94
St. Louis	27 50@42	
Baltimore	40 00	
Los Angeles	23 75	15 00
Montreal	37 00	
Atlanta	42.00	
Detroit (petroleum asphalt)	28 40	21 15
Cincinnati	32.50	24.00
Maurer, N. J. (asphalt)	27@38	
Maurer, N. J. (asphalt cement)	29@36	25@31

PAVING STONE

New York	5-in. granite	No quotations
Chicago	About 4x8x4 dressed	$3 40 sq.yd.
	About 4x8x4 common	3 05 sq.yd.
San Francisco	Basalt block 4x7x8	65 00 per M
Boston	5-in. granite	4 20 sq.yd.
Atlanta	Granite	2 00 sq.yd.
Detroit	Granite, 26½ blocks per sq.yd.	107 00 per M
Baltimore	Granite	2 25 sq.yd.
Montreal	Granite	6 50 sq.yd.
New Orleans	Granite	3 00 sq.yd.
Cincinnati	Granite	3 25 sq.yd.
St. Louis	Granite	3.40 sq.yd.

FLAGGING

New York	Bronx	$0 25	sq.ft.
	Manhattan, 4 ft.	.26	sq.ft.
	Queens, 5 ft.	.26	sq.ft.
	6x20-in. cross-walk	.95	lin.ft.
Chicago	18 in. wide	.70	lin.ft.

CURBING—Bluestone per lineal foot, in New York, costs 70c. for 5x16 in., 80c. for 5x18 in.

WOOD BLOCK PAVING

	Size of Block	Treatment	Per Sq.Yd.
New York	3½	Ib	$2.99
New York	4	Ib	3.33
Boston	3	Ib	3 45
Chicago	4	Ib	3 75@4 00
Chicago	3½	Ib	3 25@3 50
St. Louis	3½	Ib	3 05
St. Louis	4	Ib	3 50
Seattle	4	Ib	Off market
Minneapolis	3½	Ib	2.32
Atlanta	3½	Ib	2 30
New Orleans	3	Ib	2 99
New Orleans	3½	Ib	3 42
New Orleans	4	Ib	3 85
Dallas	4	18	3 90
Baltimore	3½	Ib	3 75
Montreal	4	Ib	4 90
Detroit	3½	Ib	3 40

CONSTRUCTION MATERIALS

SAND AND GRAVEL—Price for cargo or carload lots is as follows, per cu.yd.:

	Gravel 1½ In. Current	Gravel 1½ In. One Year Ago	Gravel ¾ In. Current	Gravel ¾ In. One Year Ago	Sand Current	Sand One Year Ago
New York	$2.50	$2 25	$2.50	$2 25	$1 25	$1 25
Denver	2 00	1 80	1 80	1 80	1 60	1 40
Chicago	2 75	2 00	2 75	2 00	2 75	2 00
St. Louis	1 65	1 78	1 70	1 82	1 70	1 68
Seattle	1 50	1 25	1 50	1 25	1 50	1 25
Dallas	1 75	2 50	1 75	2 50	1 75	2 00
Minneapolis	2 00	1 50	....	1 35	1 00	75
Cincinnati	2 00	....	2 00	....	1 30	1 30
San Francisco	2 50	1 50	2 50	1 50	1 65	1 50
Boston, per ton	2 65	2 85	2 65	2 85	2 00	2 00
New Orleans	2.85	3 00	....	....	1.65	1 40
Los Angeles	1 55	1 50	1 45	....	1.00	1 00
Atlanta, per ton	2.80	2 25	....	2 25	1 50	1 15
Detroit	1 85	2 50	1 85*	2 00	2 50	1 85
Baltimore, per ton	1 40	1 40	1 60	1 60	70	70
Montreal, per ton	1 50	1 15	1 75	1 50	1 50	1 40

CRUSHED STONE—Price for cargo or carload lots is as follows, per cu.yd.:

	1½ In. Current	1½ In. One Year Ago	¾ In. Current	¾ In. One Year Ago
New York	$1.90@2.00	$1 85	$2.15	$2 00
Chicago	2.75	2.00	2.75	2 15
St. Louis	1 85	1.65	1 85	1 65
Dallas	2.10	3.50	2.10	3 50
San Francisco	2 50	1 50	2.50	1 50
Boston	3 00*(del)	3 25	3.00*(del)	3 25
Minneapolis	2 00†	1 50†	2.25†	1 60
Denver	....	3 75	....	3 75
Seattle (del.)	3 50	3 50	3 50	3 50
Atlanta	2.50*	3 10*	....	....
Cincinnati	2 30	....	2 15	....
Los Angeles	1 75*	1 50	1 80*	1 50
Detroit	2 00	1 75	2 00*	1 75
Baltimore	1 75*	1 50	1.75*	1 50
Montreal	2.00*	1 75	2.10*	2 00

* Per ton. † Limestone; traprock, $1 60 and $1 80 per ton for 1½ and ¾-in.

CRUSHED SLAG—Price of crushed slag per net ton in carload lots:

	1½-In.	¾-In.	Roofing	Sand
Lebanon or Bethlehem, Pa.	$1 00	$1 00	$2 50	$0 90
East n, Pa.	1 20	1 20	3 00	1 10
Buffalo, N. Y.	1 25	1 00	2 00	1 00
East Canaan, Conn.	1 25	1 35	4 00	1 10
Birmingham, Ala.	1 25	1 25	2 05	1 00
Toledo, Ohio	1 50	1 50	2 35	....
Atlanta, Ga.	2 58	2.25	....	....

LIME—Warehouse prices:

	Hydrated, per Ton Finished	Hydrated, per Ton Common	Lump, per 200-Lb. Barrel Finished	Lump, per 200-Lb. Barrel Common
New York	$21 00	$20 00	$3 50* - at plant	$3 30*
Chicago	20 00	....	....	1 75
St. Louis	26 00	20 00	....	4 12*
Boston	29 00	26 00	3 80	3 55
Dallas	....	25 00	....	2 50†
Cincinnati	17.60	16.60	....	13 10‡
San Francisco	25 40	22 00	....	2 25
Minneapolis	29 00	22 00 (white)	2 00	1 70
Denver	....	3 20 (bbl.)	1.00 (bu.)	....
Detroit	22 00	19 00	2 00†	1 80†
Seattle	27 00	....	3 25	....
Los Angeles	30 00	30 00	3 00*	3 00*
Baltimore	22.25	17.50	....	12.75‡
Montreal	32 00	....	16 00‡	....
Atlanta	....	18 00	....	2 00
New Orleans	....	22 50	....	2.50

* 300-lb. barrels. † Per 180-lb. barrel. ‡ Per ton.

NOTE.—Refund of 10c. per barrel.

NATURAL CEMENT—Price to dealers for 500 bbl. or over, f.o.b., exclusive of bags:

	Current	One Year Ago
Minneapolis (Rosedale)	$2 80	$1 50
Kansas City (Ft. Scott)	1 60	1 75
New Orleans	3 36	3 36
Atlanta (Magnolia)	11 00 ton	1 90
Cincinnati (Louisville)	2 75	2 25
Boston (Rosedale)	2 35	....

PORTLAND CEMENT—Current prices are for barrels in carload lots, *without* bags, to contractors:

	Current Without Bags	One Month Ago Without Bags	One Year Ago Without Bags
New York (delivered)	$3 10	$3 10	$2 80
New York, alongside dock to dealers	2 40	2 40	2 35
Jersey City (delivered)	2.64	2 89	2 47
Boston	2 87	2 87	2 42
Chicago	2 17	2 17	2 00
Pittsburgh	2 17	2 17	2 05
Cleveland	2 43	2 43	2 32
Detroit	2 51	2 51	2 08
Indianapolis	2 31	2 31	2 27
Toledo	2 51	2 51	2 12
Milwaukee	2 39	2 39	2 11
Duluth	2 10	2 10	2 10
Peoria	2 43	2 43	2 12
Cedar Rapids	2 51	2 51	2 18
Davenport	2 47	2 47	2 14
St. Louis	3 40	3 40	2 20
San Francisco	3.09	3 09	2 63
New Orleans	3.45	3 60	2 36
Minneapolis (delivered)	2 70	2 70	2 22
Denver	3 10	3 10	2 82
Seattle	3 10	3 10	2 78
Dallas	2 85	2 85	2 15
Atlanta	3 00	3 00	2 70
Cincinnati	2.87	3 32	3 00
Los Angeles	3 21	3 21	2 78
Baltimore (del.) drayload lots	3 58	2 93	2 90
Detroit	2 43	2 33	
Montreal	3 44	3 50	3 48

NOTE—Bag charge is generally 25c. each; 10c. each in New York and Jersey City.

TRIANGLE MESH—Price per 100 sq.ft. in carload lots:

PLAIN 4-INCH by 4-INCH MESH

Style Number	Sectional Area Square Inches per Ft. Width	Pittsburgh, Mill	New York, (Del'd)	Chicago	Dallas	San Francisco
032	0.032	$1.03	$1.55	$1.11	$1.11	$1.54
049	0.049	1.32	1.95	1.43	1.43	1.96
068	0.068	1.61	2.35	1.74	1.74	2.41
093	0.093	2.07	2.98	2.24	2.24	3.11
126	0.126	2.57	3.67	2.79	2.79	3.88
153	0.153	3.06	4.34	3.32	3.32	4.03
180	0.180	3.51	4.97	3.81	3.81	....
245	0.245	4.64	6.52	5.03	5.03	....
283	0.287	5.36	7.50	5.81	5.81	8.10
376	0.336	6.21	8.67	6.73	6.73	....
395	0.395	7.20	10.03	7.81	7.81	....
			PAVING			
036P	0.036	$0.79	$1.23	$0.85	$0.85	....
053P	0.053	1.12	1.68	1.21	1.21	....
072P	0.072	1.41	2.08	1.53	1.53	....
097P	0.097	1.82	1.76	1.97	1.97	....
049R	0.049	1.12	2.08	1.21	1.21	....
067R	0.067	1.49	2.64	1.53	1.53	....
089R	0.089	1.82	....	1.97	1.97	....

Made in 16-, 20-, 24-, 28-, 32-, 36-, 40-, 44-, 48-, 52- and 56-in. width in rolls 150-, 200- and 300-ft. lengths. Galvanized is about 10% higher.

EXPANDED METAL LATH—Prices in carload lots per 100 yd. for painted are as follows:

Gage	Weight	New York Delivered	Chicago	St. Louis	San Francisco	Dallas
27	233	$29.20	$29.50	$32.00	$34.20	$32.75
26	250	31.00	31.00	33.00	.....	34.50
25	300	32.75	32.40	35.00	.....	36.75
24	340	33.65	34.10	37.00	42.70	39.25
22	450	35.50	.....	40.00	.....	43.30

BARS, CONCRETE REINFORCING—Current quotations per 100 lb

ROLLED FROM BILLETS

In.	Pittsburgh, Mill	Warehouse, Uncut: New York	Chicago	Dallas	San Francisco
½ and larger	$2.00@2.35	$3.13	$3.48	$3.87	.....
⅝	2.05@2.40	3.18	3.53	3.92	.....
¾	2.10@2.45	3.23	3.58	3.97	.....
⅞	2.25@2.60	3.38	3.63	4.12	.....
1	2.50@2.85	3.63	4.18	4.57	.....

Twisted bars cut to length take extra of 27½c. per 100 lb.

ROLLED FROM RAILS

	Chicago	St. Louis	Dallas		Chicago	St. Louis	Dallas
½ in. and larger	$2.50	$2.40	$4.25	⅝	$2.90	$2.65	.....
⅝	2.55	2.45	4.30	¾	2.90	....	.....
⅞	2.65	2.50	....	.....	....	....	.....

BRICK—Contractors price per 1,000 in cargo or carload lots is as follows:

	Common: Current	One Month Ago	One Year Ago	Paving Block—3-inch*	4-inch*
New York (del.)	$21.70	$22.70	$25.00	$47.25	$53.50
New Orleans	25.50	25.50	22.50	.....	.....
Chicago	15.00	15.00	14.00	37.00	.....
St. Louis, salmon	15.00†	15.00	16.00	.....	.....
Denver, salmon	14.00	14.00	17.00	.....	.....
Dallas	18.50	25.00	24.00	44.00	.....
San Francisco	18.00	18.00	15.00	.....	44.38
Los Angeles	15.50	15.50	12.50	(not used)	
Boston (del.)	25.00	25.00	30.00	49.25	57.25
Minneapolis (del.)	18@20	20@22	20.00	37.00	43.00
Kansas City	....	22.00	20.00	.....	.....
Seattle	19.00	19.00	15.00	48.00	53.50
Cincinnati	21.00	22.00	22.00	44.00	.....
Montreal (del.)	18.00	20.00	17.50	100.00	120.00
Detroit	18.00	18.00	21.00	46.00	52.00
Baltimore (del.)	20@25	22.50	20.00	40.00‡	44.00‡
Atlanta	12.00	13.00	....	.....	.....
New Orleans	21.50	24.00	.....	.....	.....

* For paving blocks 3½x8½x3 and 3½x8½x4 respectively. †Hard brick $20.50 in St. Louis. ‡ Vitrified, f.o.b. plant, Baltimore.

HOLLOW TILE—Price per block in carload lots for hollow building tile

	New York: Current on Trucks	New York: One Year Ago	Chicago	St. Louis	San Francisco	Perth Amboy N. J., Factory
4x12x12	.....	$0.1895	$0.12	$0.112	$0.145	.....
6x12x12	.....	.2526	.18	.147	.21	.....
8x12x12	.....	.....	.216	.207	.29	.....
10x12x12	.....	.....	.27	.237	.....	.....
12x12x12	.....	.....	.324	.282	.....	.....

Note—Definite prices not decided upon in New York

	4x12x12	8x12x12	12x12x12
Boston	$0.173	$0.28	$0.43
Minneapolis	.096	.168	.264
Minneapolis (delivered)	.104	.182	.286
Cincinnati	.102	.169	.23
Kansas City		No prices obtainable	
Denver	.11	.18	.25
Seattle	.13	.175	.30
Los Angeles	.11	.192	.23
New Orleans	.21	.35	.50
Detroit	.15	.27	.39
Montreal	.25	.31	.38
Baltimore	.16	.27	.45
Atlanta	.12	.20	.....

STRUCTURAL MATERIAL—Following are base prices f.o.b. mill, Pittsburgh together with quotations per 100 lb. from warehouses at places named:

	Pittsburgh, Mill	New York (Del.)	New York 1 Yr. Ago	St. Louis	Chicago (del.)	San Francisco
Beams, 3 to 15 in	$2.00@2.45	$3.33	$5.00	$3.32½	$3.13	$4.85
Channels, 3 to 15 in	2.00@2.45	3.33	5.00	3.32½	3.13	4.85
Angles, 3 to 6 in., ¼ in thick	2.00@2.45	3.33	5.00	3.32½	3.13	4.85
Tees, 3 in. and larger	2.00@2.45	3.33	5.00	3.32½	3.13	4.85
Plates	2.00@2.65	3.33	5.00	3.32½	3.13	5.50

RIVETS—The following quotations are per 100 lb.:

STRUCTURAL

	Warehouse: Pittsburgh, Mill	New York: Current	New York: One Yr. Ago	Chicago	St. Louis	San Francisco	Dallas
½ in. and larger	$3.70@$3.75	$5.08	$6.00	$5.08	$4.97½	$7.05	$6.85

CONE HEAD BOILER

½ in. and larger	3.80@3.85	5.18	6.10	5.18	5.07½	7.15	6.85
⅝ and ¾	3.95@4.00	5.33	6.25	5.33	5.22½	7.40	6.85
⅞ and 1	4.20@4.25	5.58	6.60	5.68	5.47½	7.65	7.05

Lengths shorter than 1 in. take an extra of 50c. Lengths between 1 in. and 2 in take an extra of 25c. Tank rivets, 40 per cent off.

NAILS—The following quotations are per keg from warehouse:

	Pittsburgh, Mill	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	$3.00@$3.25	$4.15	$5.50	$5.20	$4.10	$4.95
Cut	....	7.65	7.75	7.75	4.75	5.00

PREPARED ROOFINGS—Standard grade rubbered surface, complete with nails and cement, costs per square as follows at manufacturing points:

	New York: 1-Ply l.c.l.	New York: 2-Ply l.c.l.	New York: 3-Ply l.c.l.	Philadelphia: 1-Ply l.c.l.	Philadelphia: 2-Ply l.c.l.	Philadelphia: 3-Ply l.c.l.
No. 1 grade	$2.15	$2.55	$3.00	$1.95	$2.30	$2.70
No. 2 grade	2.05	2.45	2.95	1.85	2.20	2.60

Slate-surfaced roofing (red and green) in rolls of 108 sq.ft. costs $2.80 per roll in carload lots and $3.05 for smaller quantities f.o.b. Philadelphia.

Shingles, red and green slate finish, cost $8.00 per square in carloads; $8.25 in smaller quantities, in Philadelphia.

ROOFING MATERIALS—Prices per ton f.o.b. New York:

Tar felt (14 lb. per square of 100 sq.ft.) per roll of 432 sq. ft	$2.80
Tar pitch (in 400-lb. bbl.) per 100 lb	2.10
Asphalt pitch (in barrels) per ton	49.50
Asphalt felt (light) per ton	98.00
Asphalt felt (heavy) per ton	102.00

SHEETS—Quotations are in cents per pound in various cities from warehouse also the base quotations from mill:

Blue Annealed	Pittsburgh, Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10	$3.20@$3.55	$4.22½	$4.68	$6.50	$4.50
No. 12	3.25@3.60	4.27½	4.73	6.55	4.55
No. 14	3.40@3.65	4.32½	5.03	6.60	4.60
No. 16	3.50@3.75	4.42½	5.13	6.95	4.70
Black					
*Nos. 18 and 20	4.05@4.20	5.30	5.80	7.05	4.80
*Nos. 22 and 24	4.10@4.25	5.35	5.85	7.10	4.85
*No. 26	4.15@4.30	5.40	5.90	7.15	4.90
*No. 28	4.20@4.35	5.50	6.00	7.25	5.00
Galvanized					
No. 10	4.50@4.70	5.60	6.35	....	5.05
No. 12	4.60@4.80	5.60	6.45	7.85	5.15
No. 14	4.60@4.80	5.60	6.45	7.85	5.15
Nos. 18 and 20	4.90@5.10	5.90	6.75	8.15	5.45
Nos. 22 and 24	5.05@5.25	6.05	6.90	8.30	5.60
*No. 26	5.20@5.40	6.20	7.05	8.45	5.75
*No. 28	5.50@5.70	6.50	7.30	8.75	6.00

* For painted corrugated sheets add 30c. per 1000 lb. for 5 to 28 gage; 25c. for 19 to 24 gages; for galvanized corrugated sheets add 15c., all gages.

LINSEED OIL—These prices are per gallon:

	New York: Current‡	New York: One Year Ago	Chicago: Current	Chicago: One Year Ago
Raw in barrel (5 bbl)	$0.73	$1.87	$0.82	$1.66

WHITE AND RED LEAD—Base price per pound

	Red — Current		Red — 1 Year Ago		White — Current	White — 1 Yr. Ago
	Dry	In Oil	Dry	In Oil	Dry and In Oil	Dry and In Oil
100-lb. keg	13 00	14 50	15 50	17 00	13 00	15 50
25 and 50-lb. kegs	13 25	14 75	15 75	17 25	13 25	15 75
12½-lb. keg	13 50	15 00	16 00	17 50	13 50	16 00
5-lb. cans	16 00	17 50	18 50	20 00	16 00	18 50
1-lb. cans	18 00	19 50	20 50	22 00	18 00	20 50

500 lb. lots less 10% discount. 2000 lb. lots less 10 2½% discount.

LUMBER

San Francisco—Prices of rough Douglas fir No. 1 common, in more than carload lots:

	Lumber Prices in Yards at San Francisco — 6-8 and 12 Ft.	10-16-18 and 20 Ft.	22 and 24 Ft.	25 to 32 Ft.
3x3 and 4	$24 50	$25 00	$26 00	$28 00
3x6 and 8	25 50	26 00	27 00	29 00
4x4-6 and 8	26 00	27 00	28 00	29 50
3x10 and 12	26 00	27 00	28 00	30 00
3x14	26 50	27 50	28 50	30 50
4x10 and 12	26 00	27 00	28 00	30 00
4x14	27 00	28 00	29 00	31 00

	24 Ft. and Under	25 to 32 Ft.	33 to 40 Ft.
6x10	$25 50	$27 50	$28 50
6x14	27 00	29 00	29 50
8x10	25 50	27 50	28 50
8x14	27 00	29 00	29 50

New York, Chicago and St. Louis

	Southern Pine — New York* — 20 Ft. and Under	22-24 Ft.	Chicago — 20 Ft. and Under	22-24 Ft.
3x4 to 8x8	$37 00	$38 00	$51 00	$52 00
3x10 to 10x10	52 00	53 00	53 00	54 00
3x12 to 12x12	58 00	59 00	55 00	56 00
3x14 to 14x14	53 00	54 00	60 00	61 00
3x16 to 16x16	60 00	61 00	65 00	66 00
3x18 to 18x18	72 00	73 00	69 00	70 00
4x20 to 20x20			72 00	73 00

* For long leaf pine. Short leaf pine up to 14 x 14 costs $15 per M. less.

St. Louis: Yellow pine, 22@24 ft. long, 3 x 12@4 x 12, $42; 2 x 16, $53; 3 x 15@4 x 16, $53; 6 x 10@8 x 10 x 10, $37; 6 x 12@12 x 12, $41; 6 x 14@14 x 14, $45; 8 x 16@16 x 16, $51.

Over 24 ft.—Add $1 for each additional 2 ft. in length up to 30 ft. for sizes 12x12 and under, for sizes over 12 x 12 add $2, for merchantable add $2 to sizes 10 x 10 and under. For pine add $2 to the price of merchantable for all size.

Other Cities

	8 x 8-In. x 20-Ft. and Under — P.	Fir	Hemlock	Spruce	12 x 12-In. 20 Ft. and Under — P.	Fir
Boston	$49 00	$55 00	$56 00	$50 00	$56 00	$58 00
Seattle		25 00				27 00
New Orleans	35 00				38 00	
Baltimore	60 00				70 00	
Cincinnati					80 00	
Montreal	78 00	78 00	68 00	78.00	79 00	100 00
Los Angeles		47 00	46 00			49 00
Detroit		Quotations f.o.b. mills only				
Denver		37 25				38 25
Minneapolis	47 00	41 00	34 00		56 00	41 00
Atlanta	27 50				40 00	
Dallas	45 00				55 00	

	1-In. Rough, 10 In. x 16 Ft. and Under — P.	Fir	Hemlock	2-In. T. and Gr. 10 In. x 16 Ft. P.	Fir
Boston	$45 00	$60 00	$45 00	$45 00	$60 00
Seattle		18.50			
New Orleans	35 00			35 00	
Baltimore	$2 50@45			40@45	
Cincinnati	26 00				
Montreal	120 00	60 00	60 00	80 00	80 00
Los Angeles		41 00	45 00		54 00
Denver		31 25			29 25
Minneapolis	40 50	29 25	35 00	35 00	31 25
Atlanta	15 00			18 00	
Dallas		33 00		42 00	

* Montreal—Up to 32 ft.; over which, $3.00 per M. increase up to 30 ft.

FREIGHT RATES

On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant steel, bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carloads of 36,000 lb.:

Baltimore	$0 33½	Detroit	$0 33
Pittsburgh	76½	Kansas City	81½
Boston	41½	New Orleans	51½
Buffalo	29½	New York	38
Chicago	38	Pacific Coast (all rail)	1 66½†‡
Cincinnati	33	Philadelphia	35
Cleveland	24	St. Louis	47½
Denver	1 35*	St. Paul	69½

Note—Add 3% transportation tax. * Minimum carload, 40,000 lb. †Minimum carload, 50,000 lb., structural steel only; 80,000 lb. for other iron or steel articles.

CONTRACTORS' SUPPLIES

STEEL SHEET PILING—The following price is base per 100 lb. f.o.b. Pittsburgh, with a comparison of a month and a year ago:

Current	One Month Ago	One Year Ago
$2.55	$3.00	$2.55@$3.65

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized are as follows:

	New York
Hercules red strand, all constructions	15%
Patent flattened strand, special and cast steel	15%
Patent flattened strand, iron rope	List
Plow steel round strand rope	30%
Special steel round strand rope	25%
Cast steel round strand rope	17½%
Iron strand and iron tiller	List
Galvanized iron rigging and guy rope	+17½%

San Francisco: Galvanized iron rigging and guy ropes +22½%; bright plow, 25% off.

Chicago: Plow steel, round strand, 30% off; flattened strand, 15%; cast steel round strand, 17½%.

Western and California territory, 25% plow steel; 22½% galvanized iron rigging and guy rope.

Montana, Idaho and Arizona, 20% plow steel; 27½% galvanized iron rigging and guy rope.

MANILA ROPE—For rope smaller than ¾-in. the price is ½ to 2c. extra; while for quantities amounting to less than 600 ft. there is an extra charge of 1c. The number of feet per pound for the various sizes is as follows: ¾-in., 8 ft.; ½-in., 6; ¼-in., 4½; 1-in., 3½; 1¼-in., 2 ft. 10 in.; 1½-in., 2 ft. 4 in. Following is price per pound for ¾-in. and larger, in 1200-ft. coils:

Boston	$0 22	Dallas	$0 29
New York	21	New Orleans	21½
Chicago	21	Los Angeles	18*
Minneapolis	23	Seattle	20
San Francisco	19	St. Louis	21
Atlanta	25	Montreal	31
Denver	20	Detroit	21
Cincinnati	22	Baltimore	25

*780-ft. coil.

EXPLOSIVES—Price per pound of dynamite in small lots and price per 25-lb. keg of black powder:

	Low Freezing 20%	Gelatin 40%	Gelatin 60%	Gelatin 80%	Black Powder
New York		$0 33½	$0 36½		
Boston	225	2425	2825	$0 365	
Kansas City	2475	27	30	34	$2 40
Seattle	1825	2025	2275	2950	2 60
Chicago	2225	2425	2675	335	2 50
Minneapolis	2222	2426	2682		2 80
St. Louis	245	28	315	3575	2 50
Denver	2250	2550	29	3325	2 70
Dallas	265*	275	3025		2 60
Los Angeles	22	27	32		3 10
Atlanta	2525	2875†	3225	3650	2 50
Baltimore	2525	2875	3175	36	2 10
Cincinnati	2425				2 65
Montreal	30	32	37	38	4 10
New Orleans	255	275†	300†		2 80

* 30 Per Cent. † Low freezing.

PILES—For spruce and plain pine piles, delivered New York, the price is as follows:

Spruce 10-in. butts, 5-in. tops, length 20-30 ft.	$11 50
Spruce 12-in. butts, 6-in. tops, length 30-40 ft.	10 50
Pine 12-in. butts, 6-in. tops, length 41-50 ft.	13 75
Pine 14-in. butts, 6-in. tops, length 51-60 ft.	22 50
Pine 14-in. butts, 6-in. tops, length 61-71 ft.	25 25

Dallas		St. Louis
6-in. x 20-ft.	$4 60	6-in. x 30-ft. $7 90
		7-in. x 30-ft. 10 10
6-in. x 30-ft.	7 10	7-in. x 35-ft. 15 55
		8-in. x 35-ft. 16 55
8-in. x 30-ft.	8 45	7-in. x 40-ft. 16 05
		8-in. x 45-ft. 27 05
8-in. x 35-ft.	10 38	8-in. x 50-ft. 28 05

OLD MATERIAL—The prices following are per gross ton paid to dealers and producers in New York. In Chicago and St. Louis the quotations are per net ton and cover delivery at the buyer's works, including freight transfer charges.

	New York	Chicago	St. Louis
No. 1 railroad wrought	$11 25	$12 50	$11 00
Stove plate	14.00	16.00	11 50
No. 1 machinery cast	18.50	16.50	14 00
Machine shop turnings	5.00	6.75	5 00
Cast borings	5.50	8.50	7 00
Railroad malleable cast	14.50	14.50	12 50
Re-rolling rails	16.00	13.00	15 00
Relaying rails	$1 00	34.00	35@40

SHIP SPIKES—Current prices per 100 lb.

In.	San Francisco — Galv.	San Francisco — Black	Seattle Black
¼	$9 20	$8 50	$8 55
⅜	8 75	6 75	8 25
½	8 60	6 60	8 30

Pittsburgh base, $4.25@$4.50 per 100 lb.